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GEOLOGY AND GROUNDWATER RESOURCES OF MONROE COUNTY, PENNSYLVANIA

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF
TOPOGRAPHIC AND GEOLOGIC SURVEY
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by Louis D. Carswell
U. S. Geological Survey
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U. S. Geological Survey

Prepared by the United States Geological Survey, Water Resources Division, in cooperation with the Pennsylvania Geological Survey

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PREFACE

This report describes the geologic and groundwater resources of a fast-growing area which is imposing increasing demands upon these vital natural resources. The population growth involves both an increased number of year-around residents, as well as a large number of seasonal residents who utilize the summer and winter vacational facilities. The availability and quality of water resources, particularly the largely underdeveloped subsurface water resources (groundwater) is a key factor in planning for the future of this area.

The comprehensive description and inventory of the geology and groundwater resources of Monroe County that this report provides is intended to serve the needs of local officials, planners, business people, and property owners, all of whom have an interest in dealing knowledgeably with the resources of the area.

ARTHUR A. SOCOLOW

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GEOLOGY AND GROUNDWATER RESOURCES OF MONROE COUNTY, PENNSYLVANIA

by

Louis D. Carswell and Orville B. Lloyd, Jr.

ABSTRACT

Monroe County is on the eastern border of Pennsylvania and includes much of the area popularly called the Poconos. It is an area long used for outdoor recreation and includes a part of the Delaware Water Gap National Recreation Area.

Water resources in the county are derived from precipitation. The Lehigh and Delaware Rivers, bordering the northwestern and southeastern parts, respectively, are the drains for surface-water and groundwater discharge and are essentially unused for water supply.

Water budgets were calculated for average conditions when annual precipitation is 45 inches. Sixty percent of this, or 27 inches, runs off and 65 percent of that runoff, or 17 inches, moves through the groundwater reservoir. Evapotranspiration varies little between wet and dry years and averages 18 inches.

Bedrock consists of Silurian and Devonian sedimentary rocks, which are intensely deformed by folding in the southeastern third of the county and are moderately deformed in the remainder. During the Pleistocene Epoch, glaciers repeatedly advanced across most of the county. The last of these advances deposited a terminal moraine that extends across the southwestern part of the county. The glaciers eroded preexisting deposits, veneered the upland, and filled valleys with unconsolidated deposits that changed surface-water drainage and altered groundwater gradients.

Water occurs in fractures and solution openings in the consolidated rocks and in intergranular openings in the unconsolidated rocks and weathered calcareous sandstones. Water that reaches the water table moves down the hydraulic gradient to points of discharge, moving both laterally and vertically away from groundwater divides and toward streams. The thickness of the freshwater system is 800 feet or more, but little water is yielded to wells by aquifers more than 500 feet below land surface. Groundwater recharge is 600 to 650 gpm/mi^2 (gallons per minute per square mile), and about 1.6 billion gallons per square mile is stored in the groundwater reservoir.

Currently the most productive wells are in consolidated-rock aquifers; however, specific-capacity data suggest that wells in the unconsolidated deposits have potentially larger yields. Well yield is affected primarily by

the distribution, size, and interconnection of the water-bearing openings and by topographic location, available recharge, well depth, location within the flow system, pumping rate and duration of pumping, and interference from other pumping wells. Potential yields of properly located, drilled, and developed wells have been calculated for the aquifers. The median yields calculated from specific-capacity data are: from the unconsolidated deposits, 200 gpm; from the Bloomsburg Formation, 100 gpm; and from the Poplar Gap Member of the Catskill Formation, 70 gpm. Median yields of the other units range from 15 to 40 gpm. In general, enough water for domestic use can be obtained throughout the county. Large-scale development and consumptive use of the groundwater will diminish baseflow of the streams.

The temperature of water measured in wells ranges from 44° to 57°F and is largely dependent on altitude of the land surface and depth to the producing zone. Hardness of water in the noncarbonate rocks averages 3 to 4 grains per gallon, or about half that of the carbonate rocks. Water from most of the bedrock aquifers is low in dissolved solids, acidic, and soft. In carbonate rocks, the water tends to be hard and slightly alkaline. Excessive amounts of iron and manganese are encountered in water from the unconsolidated deposits and, locally, from the Catskill and Shawangunk Formations.

INTRODUCTION

Monroe County is on the eastern border of Pennsylvania (Figure 1) and includes much of the mountainous area popularly called the Poconos. It is an area long used for outdoor recreation by people from metropolitan areas in the northeastern United States. The establishment of the Delaware Water Gap National Recreation Area, a part of which is on the eastern border, is expected to increase the use of the county as a recreational center. There are more than 200 hotels, motels, and camps, and the resort industry is the largest single industry. Outdoor recreation is the largest principal use of the land. Farming is the dominant land use in the southern half. There are more than 100 industrial plants, employing 4700 people. In addition, 3700 people are employed at Tobyhanna Army Depot, which is the largest single employer. The county is transected from east to west by Interstate Route 80 and from north to south by Interstate 380 and Pennsylvania Route 33. Stroudsburg, in the eastern part, is the major urban center.

The resident population according to the 1970 census was 45,422, but summer visitors raise the population to more than 100,000. Projected seasonal population figures show an approximate fourfold increase by the year 2000 (Moody and Associates and E. C. Hess Associates, 1973, p. 31, and Roy F. Weston, Inc., 1970, p. 47). During the first half of the century many

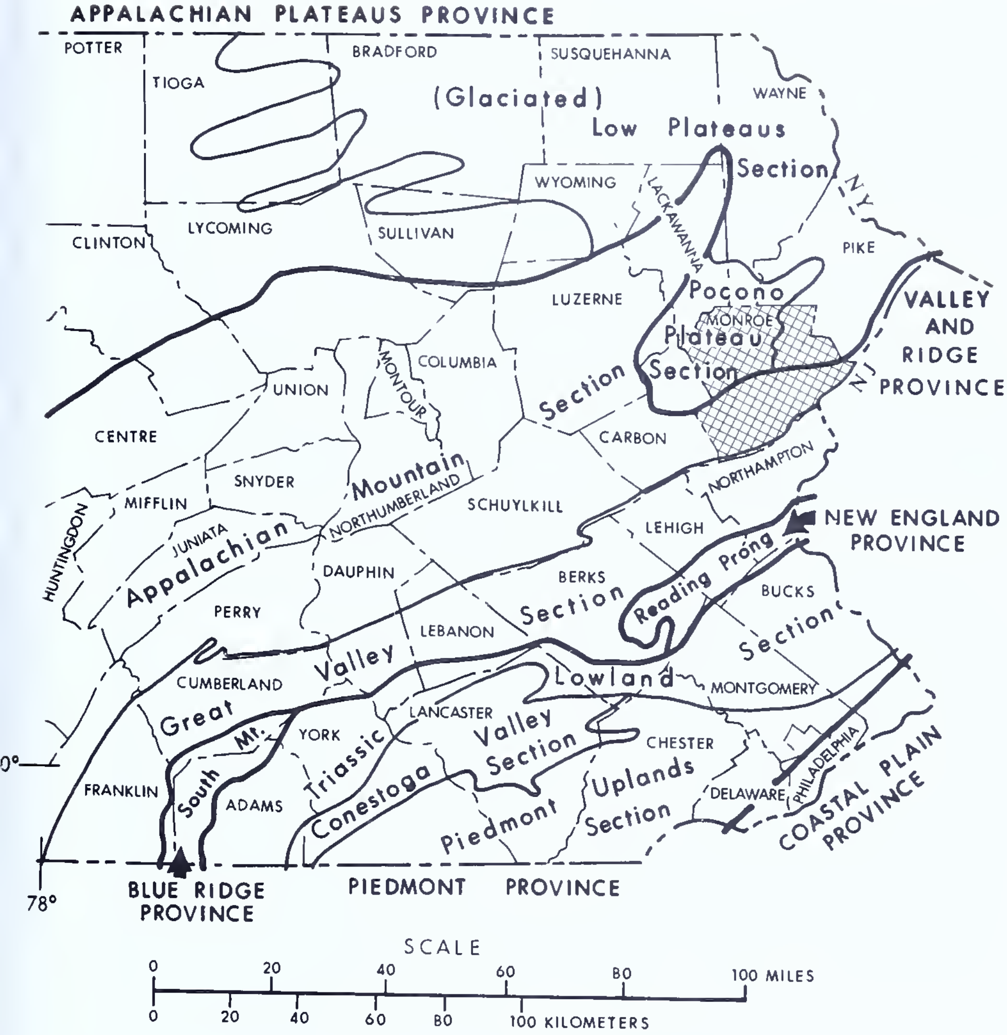

Figure 1. Map of eastern Pennsylvania showing the location of Monroe County and physiographic divisions.

of the summer visitors were concentrated in resorts. Since 1950, however, there has been a steady decline of the old resorts and a rapid increase in the purchase of recreational lots and in the construction of seasonal or second homes, many of which are in recreational subdivisions or communities. A few of the subdivisions provide water supply and sewage disposal; however, the vast majority of people in recreational subdivisions and rural areas have their own wells and on-lot sewage disposal.

Approximately 20 small private water systems serve developments and resorts and derive their supply mainly from wells and springs. The urban areas of Stroudsburg and East Stroudsburg are supplied by surface water. The Borough of Delaware Water Gap is supplied mainly from wells.

Current total water use amounts to about 8 mgd (million gallons per day), and per capita use is 75 gpd (gallons per day). Moody and Associates and E. C. Hess Associates (1973) estimate the per capita use will increase to about 100 gpd by the year 2000 and total water use will be about 35 mgd, or more than a fourfold increase.

PURPOSE AND CONTENT

The rapidly increasing population will require water at an increasing rate. In anticipation of this need, the U.S. Geological Survey, in cooperation with the Pennsylvania Topographic and Geologic Survey, began this study as a part of their continuing program to investigate the groundwater resources of Pennsylvania. The report describes the significance, occurrence, movement, availability, and quality of groundwater in the county.

ACKNOWLEDGEMENTS

The cooperation, information, and access to private and public property provided by landowners, companies, municipalities, and State and Federal agencies are gratefully acknowledged. Well drillers provided data on well locations and construction. Of particular help were the written reports of well construction and testing provided by Moody and Associates. The Pennsylvania State Game Commission gave permission to have an observation well drilled on State Game Land 214.

The well and water-quality data collected by S. W. Lohman (1937) have been incorporated into the U. S. Geological Survey's automatic data processing system and have been freely used with appreciation in this report.

Assistance in geophysical logging and in pumping and packer tests was provided by W. C. Roth, E. S. Cibort, R. L. Morningstar, and G. N. Griffin. Eugene D. Hess, formerly of the Pennsylvania Topographic and Geologic Survey, facilitated the review of well records.

GEOLOGY

Bedrock in Monroe County is composed of sandstone, conglomerate, siltstone, shale, and small amounts of carbonate rock. These rocks have been intensely deformed by folding in the southeastern third and gently folded throughout the rest of the county. The rocks are cut by systematic sets of joints and fracture cleavage. During the Pleistocene Epoch glacial ice advanced across most of the county, leaving a veneer of unconsolidated deposits that modified the surface of the land.

The geology of Monroe County has been mapped in detail by personnel of the Pennsylvania Topographic and Geologic Survey and the U. S. Geological Survey. The mapping has resulted in a series of reports and maps that are listed in the selected bibliography. Those interested in details of stratigraphy, structure, glacial geology, geomorphology, and mineral resources are referred to these reports and maps.

The stratigraphic nomenclature used in this report is that of the Pennsylvania Topographic and Geologic Survey and does not necessarily conform with established usage of the U. S. Geological Survey.

CONSOLIDATED ROCK

The consolidated rocks that immediately underlie Monroe County are of Silurian and Devonian age and are briefly described in Table 1. The geologic map (Plate 1) accompanying this report was compiled by W. D. Sevon and T. M. Berg of the Pennsylvania Geological Survey and J. B. Epstein of the U. S. Geological Survey and shows the areal distribution of the units described in Table 1.

UNCONSOLIDATED ROCK

The unconsolidated deposits of sand, gravel, silt, and clay that overlie the bedrock are the direct result of glaciation. Epstein and others (1974, p. 207) state "In the Lehighton and Palmerton quadrangles south of Stony and Chestnut Ridges, there is evidence for three and possibly four separate periods of glaciation." However, most maps of the distribution of glacial deposits in Monroe County indicate only two glacial advances. An early advance, of probable Illinoian age, covered most of the county, and a second advance, of late Wisconsinan age, covered about 75 percent. The extent of other advances is unknown because of the pervasive effects of erosion and deposition resulting from the last advance of ice.

The glacial deposits can be broadly subdivided into unstratified and stratified deposits. The unstratified deposits are till, which is composed of unsorted mixtures of boulders, sand, gravel, silt, and clay, largely of local origin and deposited directly from the ice sheet as ground or end moraine. Till masks the bedrock in most of the area and is as much as 125 feet thick in the terminal moraine. It reaches a maximum thickness of about 300 feet where it fills valleys formed before the last advance of the ice sheet.

Stratified deposits of poorly to well-sorted sand, gravel, silt, and clay were transported and deposited by glacial meltwater. These deposits were formed in contact with the ice, by streams flowing from the glacier, as outwash in floodplains and deltas, and as fine sediment in lakes and ponds formed as a consequence of glaciation. Epstein and Epstein (1967, p. 35) report extensive lake deposits in the area west of Saylorsburg, and Bucek (1971) indicates similar deposits in the general area of the Stroudsburg-Pocono airport. Peat formed in many of these lakes and slowly filled them (Cameron, 1970).

Table 1. *Description of Rock Units in Monroe County*

System	Series	Group	Formation and member		Description	Thickness (feet)
DEVONIAN	Upper		Catskill Formation	Duncannon Member	Characterized by red color; composed of grayish-red to medium-gray conglomerate, sandstone, siltstone, and shale; possesses a well-developed joint system; forms hills and ridges on the Pocono Plateau.	850 — 968
				Poplar Gap Member	Medium-gray sandstones and conglomerate and minor red shales and siltstones; rare calcareous lenses; generally has a well-developed joint system. Equivalent to the Clarks Ferry, Berry Run, and Sawmill Run Members to the west in Carbon County; forms ridges northwest of the Pocono Plateau escarpment.	850 — 1700
				Packerton Member	Greenish-gray to medium-gray, fine- to medium-grained sandstone, conglomeratic sandstone, and conglomerate; rare calcareous lenses; forms low cliffs at the Pocono Plateau escarpment; possesses a well-developed joint system.	300 — 500
				Long Run Member	Characterized by red color; consists of alternating gray sandstone and red siltstone and shale. Forms the slope on the east and south part of the Pocono Plateau below the Packerton and the core of the Weir Mountain syncline in the southwest part of the county.	2360 — 3500
				Beaverdam Run Member	Gray to greenish-gray sandstone and lesser amounts of greenish-gray siltstone and shale; contains marine fossils; has a well-developed joint system. Characterized by lack of red strata; forms a low ridge.	0 — 963
				Walcksville Member	First characteristically red, dominantly nonmarine member of the Catskill Formation. Alternating greenish and gray sandstone and red shale; intertongues with both the Beaverdam Run and Towamensing Members.	645 — 1825

DEVONIAN	Upper		Catskill Fm.	Towamensing Member	Medium-gray, fine- to medium-grained sandstone and interbedded silty shale and siltstone; arranged in cycles, and intertongues to some degree with overlying Walcksville Member; gradational contact with Trimmers Rock Formation.	0 — 300
				Trimmers Rock Formation	Gray and olive-gray, massive and fissile siltstones and minor shales. (Upper third is a ridge-forming quartzitic sandstone.) Gradational contact with Mahantango Formation; grades upward into the Towamensing Member of the Catskill Formation; possesses a well-developed joint system.	600 — 1700
	Middle	Hamilton		Mahantango Formation	Medium-dark-gray siltstone and shale; bedding largely masked by cleavage; thickens to the west.	1825 — 2400
				Marcellus Formation	Grayish-black carbonaceous fissile shale and silty shale; underlies the valleys from Bushkill to Scotia and most of the valley north and south of the Weir Mountain syncline; joints have no pronounced orientation; grades upward through about 200 feet to the Mahantango.	800
			Devonian and Silurian rocks, undiff.		Structurally complex sequence of carbonates, shales, siltstones, and minor calcareous sandstone and conglomerate.	
				Buttermilk Falls Limestone	Medium-gray argillaceous limestone, limestone, and calcareous argillite; thins to 80 feet in the western part of the county.	270
				Palmerton Sandstone	Light-gray, massive, friable, coarse- to very coarse grained, partly conglomeratic sandstone; disappears in eastern part of the county.	0 — 110
	Lower			Schoharie Formation	Medium-gray argillaceous siltstone; thins to the west.	100
				Esopus Formation	Medium-dark-gray silty shale and siltstone; thins to the west.	181
		Oriskany		Ridgeley Formation	Light-gray, fine- to coarse-grained calcareous sandstone and quartz-pebble conglomerate; minor beds of siltstone, limestone, and chert.	8 — 50
				Shriver Chert	Weathered, white to orange chert, sandstone, and conglomerate.	25 — 45

Table 1. *(Continued)*

System	Series	Group		Formation and member	Description	Thickness (feet)
DEVONIAN	Lower	Helderberg	Devonian and Silurian rocks, undiff.	Port Ewen Shale	Medium-dark-gray calcareous shaly siltstone and silty shale.	150
				Minisink Limestone	Dark- to medium-gray argillaceous limestone.	4 — 14
				New Scotland Formation	Medium- to dark-gray calcareous shale and argillaceous limestone.	63 — 81
				Coeymans Formation	Gray, argillaceous and arenaceous limestones, calcareous sandstone, and conglomerate.	53 — 112
SILURIAN	Upper			Rondout Formation	Gray calcareous shale, argillaceous limestone, and dolomite.	25 — 37
				Decker Formation	Conglomerate, calcareous sandstone and siltstone, argillaceous and arenaceous limestone, and dolomite.	87
				Bossardville Limestone	Dark-gray argillaceous limestone.	100
	Middle and Upper			Poxono Island Formation	Olive-gray to green, calcareous and dolomitic shale and dolomite, sandstone, and siltstone.	700
				Bloomsburg Formation	Red, green, and gray sandstone, siltstone, and shale and minor conglomeratic sandstone.	1500
	Lower and Middle			Shawangunk Formation	Quartzose sandstone and conglomerate, and some siltstone and shale; forms the crest of Kittatinny and Blue Mountains.	1400
ORDOVICIAN	Middle and Upper			Martinsburg Formation	Dark-gray to grayish-black claystone slate; underlies a small area between the northern end of Blue Mountain and Kittatinny Mountain, near Blue Mountain Pines.	

The effect of glaciation was to erode preexisting deposits, veneer much of the county with till, partially fill valleys, displace surface-water divides, and alter the existing aquifers by changing gradients and divides and creating new aquifers in the valley fill. In areas covered with till, the capacity for infiltration of precipitation is generally poor, whereas in areas of outwash, it is generally good. Where outwash deposits are below the water table, they form a significant groundwater reservoir. Such deposits occur in the valleys of the Lehigh and Delaware Rivers, in the broad valley underlain by the Marcellus Shale extending from Bushkill to Saylorsburg, around the Weir Mountain syncline, and in the valleys that drain the eastern and southern slopes of the Pocono Plateau.

Recent alluvium has been deposited on floodplains of the rivers and creeks, and colluvium covers the upper slopes of Kittatinny and Blue Mountains and the southern and eastern upper slopes of the Pocono Plateau. A landslide has been mapped in northern Chestnuthill Township (Berg, 1975, p. 51).

STRUCTURE

Monroe County lies within two physiographic provinces, the folded Appalachian Mountain section of the Valley and Ridge province and the Pocono Plateau section and Glaciated Low Plateau section of the Appalachian Plateaus province (Figure 1). Each province is characterized structurally by a differing type and degree of deformation; however, the general alignment of structural trends of the entire area is persistent and is approximately N60-70E. The rocks of the Pocono Plateau section dip northwest at progressively gentler dips away from the transition zone that separates the Pocono Plateau section from the folded Appalachian Mountain section.

The rocks of the Pocono Plateau section have been gently folded and contain few faults. In contrast, the rocks of the folded Appalachian Mountain section are intensely deformed by folding and faulting. The crests of Blue Mountain and Kittatinny Mountain form the southeast boundary of the county. These mountains are parts of a single narrow sinuous ridge supported by the upturned resistant rocks of the Shawangunk Formation. The Shawangunk dips steeply to the northwest and is locally overturned. The sinuosity of the ridge is a reflection of minor anticlinal and synclinal folds. Other structural features in the section are the Weir Mountain syncline and the Lehighton anticline in the southwest and smaller folds that occur throughout the area. Both the Plateau section and Appalachian Mountain section have systematic joints and cleavage and exhibit fracture traces and lineaments.

Fractures

The major sets of systematic fractures that cut the consolidated rock in Monroe County dip very steeply and in places are vertical. Two major sets exist, one oriented parallel to the regional structural grain (longitudinal fractures) and having strikes of N50-70E; the other major set is at right angles to the structural grain (transverse fractures) and strikes N20-30W. Several minor sets of fractures form oblique angles to the structural grain, such as N20-30E and N28-40W. Much of the water in the bedrock is stored in and transmitted through the openings along these fractures and along bedding planes. These openings are believed to become fewer and tighter with increasing depth below the land surface.

POROSITY AND HYDRAULIC CONDUCTIVITY

Primary porosity and hydraulic conductivity are low in the consolidated rocks. Secondary porosity and hydraulic conductivity have been developed along fractures and bedding planes in the clastic rocks, especially in the carbonate rocks as the result of solution. The principal cementing material binding the clastic grains of the sedimentary rocks is made up of chlorite, sericite, hematite, and silica; all are comparatively insoluble in groundwater. Exceptions to the above generalization are the sandstone beds of the Oriskany, Palmerton, Decker, and Coeymans Formations. These rocks have carbonate cement that is comparatively soluble in groundwater. Where the carbonate cement has been weathered or removed by circulating groundwater, a moderately large amount of porosity and hydraulic conductivity is developed. Wells in these sandstones then may need well screens to prevent caving.

In the southwestern part of the county, between Saylorsburg and Kunkletown on Chestnut and Cherry Ridges, residual white clay deposits and saprolites have formed in the limy shales and shaly limestones of Silurian and Devonian age. These deposits are beyond the southwestern limit of the late Wisconsinan glaciation. If similar deposits existed to the northeast, they were removed by glacial erosion. The extent and thickness of these deeply weathered deposits are unknown; however, according to Epstein and Hosterman (1969, p. 95), 182 feet of clay was penetrated by an exploratory borehole without reaching unweathered rock, and a recently drilled water well 3 miles south of Saylorsburg penetrated 400 feet of these deposits. Presumably, the depth to which carbonate has been leached extends below the interval of white clay into a zone of highly weathered rock, and there is a possibility that a significant groundwater reservoir has been formed in the secondary porosity produced by weathering beneath the area where the saprolite has been formed.

SUMMARY OF WATER-BEARING AND WATER-QUALITY CHARACTERISTICS OF THE AQUIFERS

The important water-bearing and water-quality characteristics of the aquifers are discussed in the following pages and summarized on Plate 1. Yield characteristics are derived from the specific capacities shown in Table 6, using an assumed drawdown of 25 feet for the unconsolidated aquifers and 50 feet for the consolidated aquifers.

UNCONSOLIDATED ROCKS

Sand and Gravel

Saturated sand and gravel deposits constitute the most potentially productive aquifers. The thickest such deposits are found in the river valleys (Plate 1). If a storage capacity of 15 percent and an average saturated thickness of 65 feet is assumed, the unconsolidated deposits shown on Plate 1 store about 70 billion gallons of water. In addition to this stored water, these deposits probably receive about 8 billion gallons of water per year as recharge from precipitation on the basis of water-budget estimation. Further, because of their valley location, most of the groundwater discharge flows through these deposits. Thus, tremendous volumes of water could be withdrawn from the unconsolidated materials. If large withdrawals are planned, careful consideration should be given to the potential effect on streamflow.

Test drilling can be used to find the areas underlain by coarse, well-sorted, saturated deposits where high-yielding wells can be developed. Specific-capacity data indicate that one of every four wells located, drilled, and developed for high yield will probably produce 400 gpm or more, with 25 feet of drawdown after 24 hours of pumping. In general the chemical quality of the water is good, but excessive concentrations of iron and manganese may be encountered. Dissolved solids average less than 100 mg/l, and the water will be acidic and soft. Because the unconsolidated deposits lie at the surface, they are particularly vulnerable to the degradation of the water quality.

CONSOLIDATED ROCKS

Catskill Formation

The sandstones and siltstones of the Catskill Formation crop out or are covered only by unconsolidated deposits over about 70 percent of the county (Plate 1). Most of the recreational and resort areas are on the Catskill Formation and depend on it for their water supply. On the average, one of every four wells located, drilled, and developed for high yield will probably produce about 75 gpm or more, with 50 feet of drawdown after 24 hours of pumping. Wells in the Poplar Gap Member will probably produce about 215 gpm, but wells in the Towamensing Member will only produce about 30 gpm. Chemical analyses of water from wells in the Catskill Formation indicate that dissolved-solids concentration averages about 100 mg/l. The water is soft and acidic, and locally contains excessive concentrations of iron and manganese.

Trimmers Rock Formation

The siltstone of the Trimmers Rock Formation crops out or is covered only by unconsolidated deposits over a little more than 3 percent of the county. Specific-capacity data indicate that one of every four wells located, drilled, and developed for high yield produces 90 gpm or more, with 50 feet of drawdown after 24 hours of pumping. The chemical quality of water from these rocks is very similar to that from the Catskill Formation. Dissolved solids average about 110 mg/l, and the water is soft and acidic.

Mahantango Formation

The siltstone of the Mahantango Formation crops out or is covered only by unconsolidated deposits over 8.5 percent of the county. About 25 percent of the wells located, drilled, and developed in this formation for high yield will probably produce 70 gpm or more, with 50 feet of drawdown after 24 hours of pumping. Water from wells in the Mahantango is much like that from wells in the Catskill and Trimmers Rock Formations. Dissolved solids average about 100 mg/l, and the water is generally soft and acidic.

Marcellus Formation

The shale of the Marcellus Formation crops out or is covered only by unconsolidated deposits over a little less than 5 percent of the county. This formation lies beneath a broad valley that is partly filled with thick saturated deposits of unconsolidated material. The combination of topographic position and the presence of the overlying saturated deposits makes it possible to develop very productive wells in what might otherwise be a rather poor aquifer. One of every four wells located, drilled, and developed for high yield will probably produce 110 gpm or more, with 50 feet of drawdown after 24 hours of pumping. Dissolved solids in water from wells in the Marcellus Formation average about 100 mg/l. The water is soft to moderately hard and slightly acidic to neutral.

Devonian and Silurian Rocks, Undifferentiated

The limestone, dolomite, calcareous shale, and sandstone formations of this unit crop out or are covered only by unconsolidated deposits over about 9 percent of the county. Moderately large yields can be developed from wells in most of the formations in this unit. About one in four of the wells located, drilled, and developed for high yield will probably produce 160 gpm or more, with 50 feet of drawdown after 24 hours of pumping. In the purer carbonate rocks, like the Buttermilk Falls and the Poxono Island Formations, higher yields can be expected. Dissolved solids in water from wells throughout this unit range from about 100 to 400 mg/l and average about 250 mg/l. The water ranges from moderately hard to very hard and from slightly acidic to slightly alkaline. Higher concentrations of dissolved solids, hardness-causing constituents, and alkalinity are found in water from wells in the purer carbonate rocks.

Bloomsburg Formation

The sandstones, siltstones, and shales of the Bloomsburg Formation crop out or are covered only by unconsolidated deposits over a little more than 3 percent of the county. This formation occurs on the northern flank of Kittatinny and Blue Mountains and is covered to a great extent by saturated talus and colluvial deposits derived from the weathered conglomerate and sandstones of the Shawangunk Formation, which forms the crests of the mountains. The Bloomsburg Formation is the most productive consolidated-rock aquifer. One of every four wells located, drilled, and developed for high yield will probably produce 250 gpm or more, with 50 feet of drawdown after 24 hours of pumping. The concentration of dissolved solids in water from the Bloomsburg Formation averages about 100 mg/l. In addition, the water is soft or moderately hard and slightly acidic.

Shawangunk Formation

The conglomerate and quartzose sandstone of the Shawangunk Formation crop out or are covered only by unconsolidated deposits over less than 2 percent of the county. Because these rocks form the relatively uninhabited crests of Kittatinny and Blue Mountains they are used very little for water supply. Thus, very few data are available to appraise their water-bearing and water-quality characteristics. Data from well Mo-199, drilled at Mount Minsi for the National Park Service, indicate water levels may be very deep, possibly greater than 200 feet, and yields small, possibly less than 5 gpm. The concentration of dissolved solids in water from well Mo-199 was only about 50 mg/l, but the concentrations of iron and manganese (6.2 and 0.43 mg/l, respectively) far exceeded the maximums (0.3 and 0.05 mg/l, respectively) recommended by the U. S. Environmental Protection Agency (1975). In summation, water from these rocks is probably very soft, acidic, and corrosive.

WATER BUDGET

Water budgets were calculated for seven drainage basins (see Figure 2 and Table 2). The period 1960-75 was used to represent normal climatic condi-

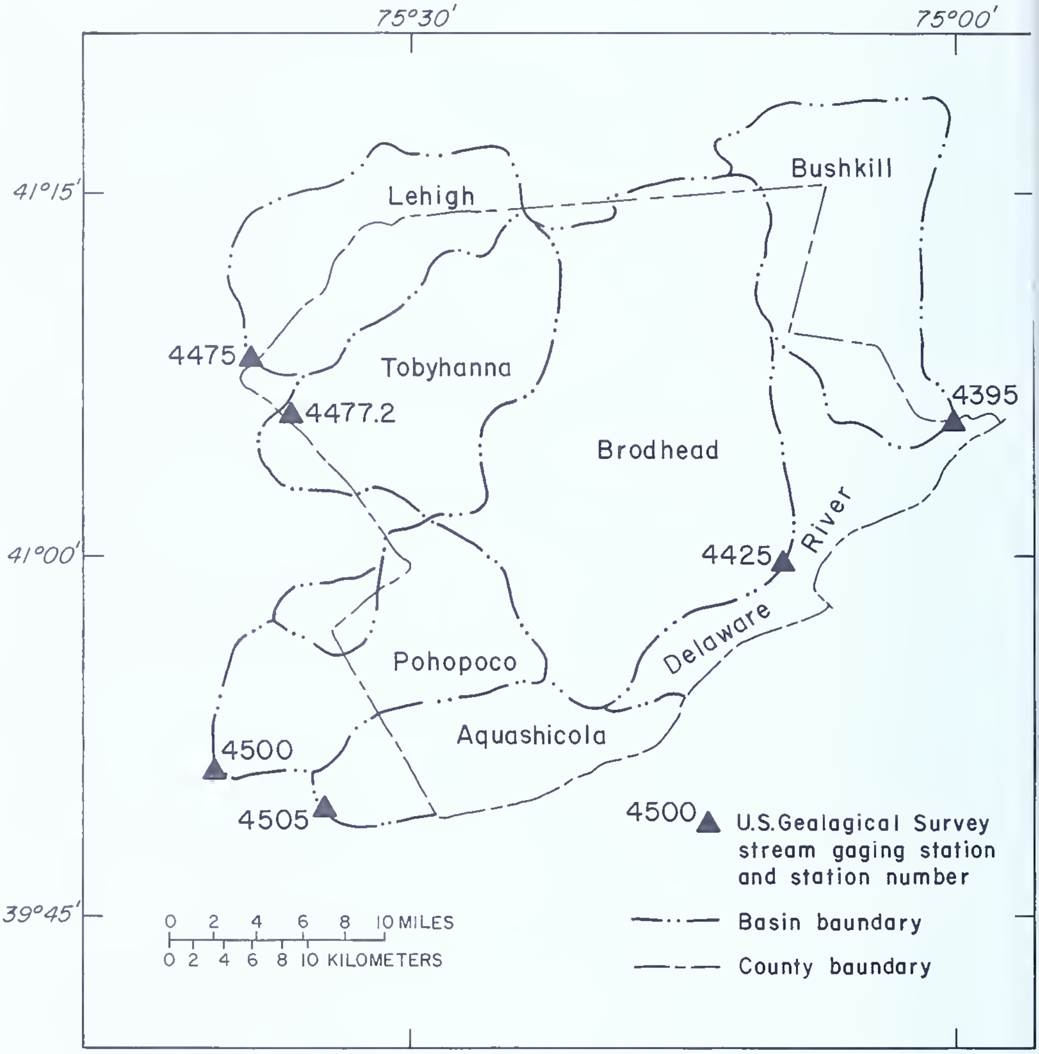

Figure 2. Map showing drainage basins and gaging stations.

tions, as it is similar to the average conditions of the much longer period 1921-50 used by Parker and others (1964) in their study of the Delaware River basin. The period 1963-66 represents dryer-than-normal and from 1972-75 represents wetter-than- normal conditions.

The water budgets were determined on a calendar year basis from the following equation and assuming the system is in a steady-state condition:

$$P = R + WL$$

where P = precipitation (rain and snow),
R = runoff (overland runoff and groundwater discharge),
and WL = water loss (primarily evaporation and transpiration).

Table 2. *Water Budgets for Selected Drainage Basins*

(Units in inches)

	BASIN NAME						
	Bushkill	Brodhead Creek	Lehigh River	Tobyhanna Creek	Pohopoco Creek	Aquashicola Creek	Area-weighted average[2]
USGS gaging station	4395	4425	4475	4477.2	4500	4505	
Drainage area (square miles)	117	259	92	118	109	77	
AVERAGE VALUES FOR 1960-75							
(P) Precipitation[1]	44.82	45.45	43.88	46.36	46.00	42.72	45.09
(R) Runoff	26.33	28.20	26.03	28.91	26.33	25.29	27.22
(WL) Water loss	18.49	17.25	17.85	17.45	19.67	17.43	17.87
AVERAGE VALUES FOR 1963-66 (4 dry years)							
(P) Precipitation[1]	35.89	36.46	34.34	36.99	36.57	33.32	36.20
(R) Runoff	16.38	17.79	17.22	19.46	16.76	16.11	17.46
(WL) Water loss	19.51	18.67	17.12	17.53	19.81	17.21	18.74
AVERAGE VALUES FOR 1972-75 (4 wet years)							
(P) Precipitation[1]	53.03	56.25	54.33	57.42	55.75	52.31	55.23
(R) Runoff	37.15	40.32	35.84	40.22	37.69	34.79	38.37
(WL) Water loss	15.88	15.93	18.49	17.20	18.06	17.52	16.86

[1] Precipitation was contoured and then area weighted for each basin.

[2] Area-weighted average is for the five stations shown and is presumed to be representative of the county.

PRECIPITATION

Precipitation is about 45 inches per year. More than 50 inches falls annually in the west-central part near Long Pond. Between 41 and 45 inches falls annually in the northern part (Figure 3).

Average annual precipitation was about 9 inches below normal (45 inches) from 1963 through 1966 and about 10 inches above normal from 1972 through 1975 (Table 3). The areal distribution of the precipitation during these two periods was similar to that shown in Figure 3; the largest amounts occurred near Long Pond and the smallest amounts along the northern and southern boundaries of the county.

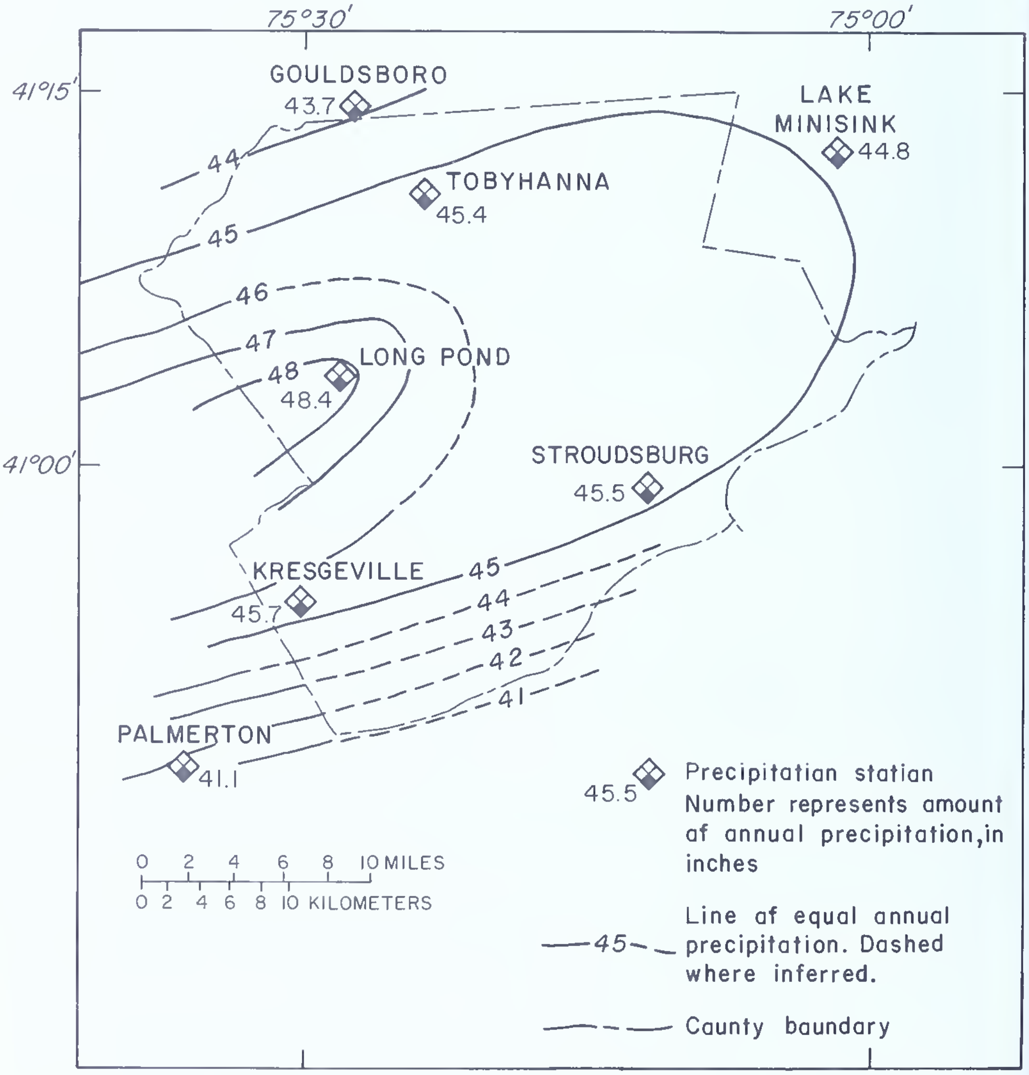

Figure 3. Map showing average annual precipitation, 1960-75.

Table 3. *Groundwater Contribution to Streamflow for Selected Basins*

Basin name and gaging station number	1963 Precipitation 9 inches below normal			1969 Precipitation approximately normal			1973 Precipitation 10 inches above normal			1963, 1969, 1973 Basin average		
	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water	Total runoff (inches)	Ground-water contribution (inches)	Percent ground-water
Bushkill 4395	16.75	12.01	72	26.28	16.55	63	39.74	27.83	70	27.59	18.80	68
Brodhead Creek 4425	17.16	11.67	68	26.80	16.82	63	44.60	30.47	68	29.52	19.65	66
Lehigh River 4475	15.56	10.98	71	23.91	16.17	68	38.42	25.50	66	25.96	17.55	68
Tobyhanna Creek 4477.2	19.01	13.54	71	29.54	18.80	64	45.47	29.99	66	31.34	20.78	67
Pohopoco Creek 4500	15.96	10.38	65	27.88	16.07	58	40.91	31.29	76	28.25	19.25	67
Aquashicola Creek 4505	15.04	11.90	79	23.29	16.91	73	36.07	25.71	71	24.80	18.17	74
Average weighted area	16.79	11.76	70	26.58	16.90	64	41.89	29.04	69			

RUNOFF

Average annual runoff from 1960 to 1975 ranged from about 25 inches in the Aquashicola Creek basin to 29 inches in the Tobyhanna Creek basin (see Figure 2 and Table 3). The average annual runoff from the area was 27 inches, or 60 percent of the average annual precipitation. During the periods 1963-66 and 1972-75 average runoff varied almost directly with the difference in average annual precipitation. From 1963 through 1966, annual runoff, like precipitation, was 9 inches below normal; from 1972 through 1975 they were both between 10 and 11 inches above normal. Runoff amounted to about 50 percent of precipitation during the dry period and about 70 percent of precipitation during the wet period.

WATER LOSS

Nearly all the net water losses listed for the budget periods were caused by evaporation and transpiration. Other net losses probably amount to less than 2 inches per year and are probably a result of flow of groundwater below the base streams and out of the basin. The data in Table 3 indicate the average amounts of water lost annually are fairly constant. Regardless of the amount of annual precipitation, 16 to 20 inches were lost to evaporation and transpiration. These water losses are fairly small, only amounting to about 40 percent of precipitation, as compared with those determined in south-central Pennsylvania, where water losses were about 65 percent of precipitation (Lloyd and Growitz, 1977). The small losses are largely a result of the low average annual temperature (about 48°F) in the relatively high average altitudes in Monroe County. More than 50 percent of the county is over 1000 feet above sea level, and the highest altitudes on the Pocono Plateau are more than 2100 feet above sea level.

GROUNDWATER

CONTRIBUTION TO RUNOFF

Streamflow hydrograph separations indicate that about two thirds of the average annual runoff in Monroe County flows through the rocks and unconsolidated sediments (the groundwater reservoir) before it is discharged to the streams. Streamflow hydrographs for all the basins were separated into overland flow and groundwater discharge components by a method described by Linsley and others (1958, p. 156-157). The data in Table 3 indicate there is only a small amount of variation (on the average ± 5 percent) in the proportion of groundwater contribution to streamflow. This is true for all possible comparisons of basins and weather conditions listed in the table.

RECHARGE

The data in Tables 2 and 3 indicate that during periods when precipitation was approximately normal (45 inches), recharge was between 16 and 19 inches per year, or between 530 and 630 gpm/mi^2. When the annual precipitation was 9 inches below normal, recharge was 10 to 13 inches per year, or between 330 and 430 gpm/mi^2; and when the annual precipitation was 10 inches above normal, recharge was 25 to 30 inches per year, or 830 to 990 gpm/mi^2.

Recharge occurs throughout the upland areas at rates dependent on the composition and texture of surface materials and on the slope of the land surface. It is largely precluded from the upper steep slope of the Pocono escarpment, where bedrock is much exposed, but is facilitated along the base of the escarpment in the talus and glacial outwash. The talus along the lower flanks of Kittatinny and Blue Mountains is also a good recharge area and is probably largely responsible for the high-yielding wells reported from the Bloomsburg Formation in this area. Kames and kame terraces along the flanks of the major valleys are also good recharge areas. Areas of low recharge result from housing developments and shopping centers, where large areas of the land surface are covered by impermeable surfaces and where storm drainage and snowmelt are removed as rapidly as possible.

OCCURRENCE AND MOVEMENT

The water table is a subdued expression of the surface topography. In most of Monroe County the upper surface of this saturated zone is in unconsolidated materials (glacial deposits or weathered bedrock) that blanket the bedrock and typically range in thickness from 30 feet to more than 300 feet. Water occurs in and moves through void spaces of the unconsolidated materials. In unweathered bedrock, whether lying beneath unconsolidated materials or at land surface (as along the escarpment of the Pocono Plateau), water occurs in and moves through fractures and solution openings.

Three types of flow systems have been recognized in the consolidated rocks of the county—local, intermediate, and regional. Much of the water in the shallow part of the aquifer moves laterally through local flow systems to points of discharge in nearby streams. The divides separating local groundwater flow systems generally coincide with surface-water divides, particularly at the water table (see Figure 4). However, variations in recharge and discharge during the year, or in pumping of wells, may change the position of groundwater divides.

Measurements of water levels in the shallow and deep parts of wells in the area using packers (see Appendix A) indicate that water also moves vertically into the deeper flow systems. The regional flow system discharges west-

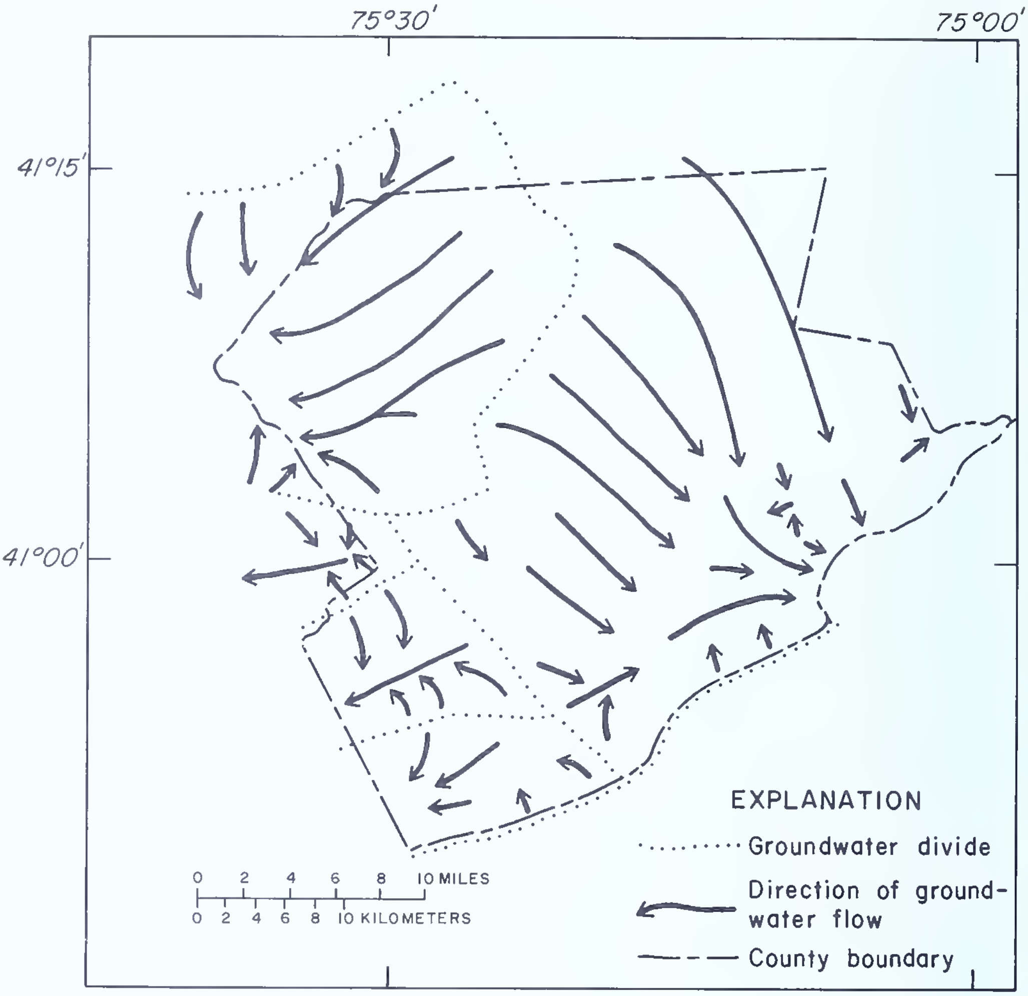

Figure 4. Map showing generalized groundwater divides and direction of groundwater flow at and near the top of the zone of saturation in Monroe County.

ward and southwestward to the Lehigh River in the western third of the county and eastward and southeastward to the Delaware River elsewhere. The intermediate flow system discharges to the major tributaries of these two rivers. Only a small amount of the water that reaches the groundwater reservoir passes beneath the local basins and into the deeper parts of the aquifer.

As water moves through the aquifer along flow paths from recharge to discharge areas there is a progressive decrease in the potential energy in the flow system, which is measured as a progressive decrease in hydraulic head regardless of the actual direction of flow. The decline in hydraulic head is the loss of energy caused by the frictional resistance to flow in moving the water through the rock or through joints and fractures to areas of discharge. The maximum head loss in the flow systems in Monroe County is about 1700 feet in a distance of about 15 miles. This maximum head loss is the difference between the water table in the eastern part of the Pocono Plateau (altitudes above 2000 feet) and the discharge area along the Delaware River (300 feet in altitude). In vertical sections through the aquifer of a particular site the head change from the top of the zone of saturation to the base of the regional flow system can be as much as 400 feet in areas where there is an abrupt and large topographic break such as along Kittatinny Mountain and the east and southern front of the Pocono Plateau. In most of the county the head difference between the top and the bottom of the freshwater flow systems is on the order of tens of feet.

Most deep water wells in bedrock have only a few tens of feet of casing, and the remaining uncased part of the well typically penetrates several different water-bearing zones that are each under a different hydraulic head. Because of the comparatively small resistance to flow in the open borehole, these wells act as short circuits in the natural flow system (analogous to short circuits in electrical systems). Water flows through the wells from zones of higher head (producing zones) to those of lower head (thieving zones), and a cone of depression of hydraulic head develops around the producing zone and a recharge cone develops in the vicinity of the thieving zone. These short circuits in the natural flow system may connect local, intermediate, and regional flow systems and transmit water from one system to another. Short-circuited flow was measured in over 30 wells by geophysical logging techniques. Figure 5 shows the direction and amount of flow in five of these wells.

In valley bottoms, particularly in those that are major drains or discharge areas for the flow system, the deepest water-bearing zones generally have the highest hydraulic heads. Thus, upward flow occurs in wells drilled into these zones and may result in flowing wells. However, water from the deeper zones may discharge into shallow zones and give no obvious indication of the flow within the wells at land surface. The amount of flow depends on the difference in head between the water-bearing zones penetrated and on the location and hydraulic conductivity of the zones. In comparison with nearby shallow wells, the deep wells that have upward flow have higher water levels, their water temperature is higher, and their water generally contains more dissolved solids.

When a well penetrates progressively higher heads at greater depths, the resultant higher composite water level increases the amount of drawdown available to the well when it is pumped, and decreases the energy required to lift the water from the well. Such upward flow is not always advantageous, for it may transmit water containing relatively large amounts of dissolved solids into shallow aquifers that contain small concentrations of dissolved solids.

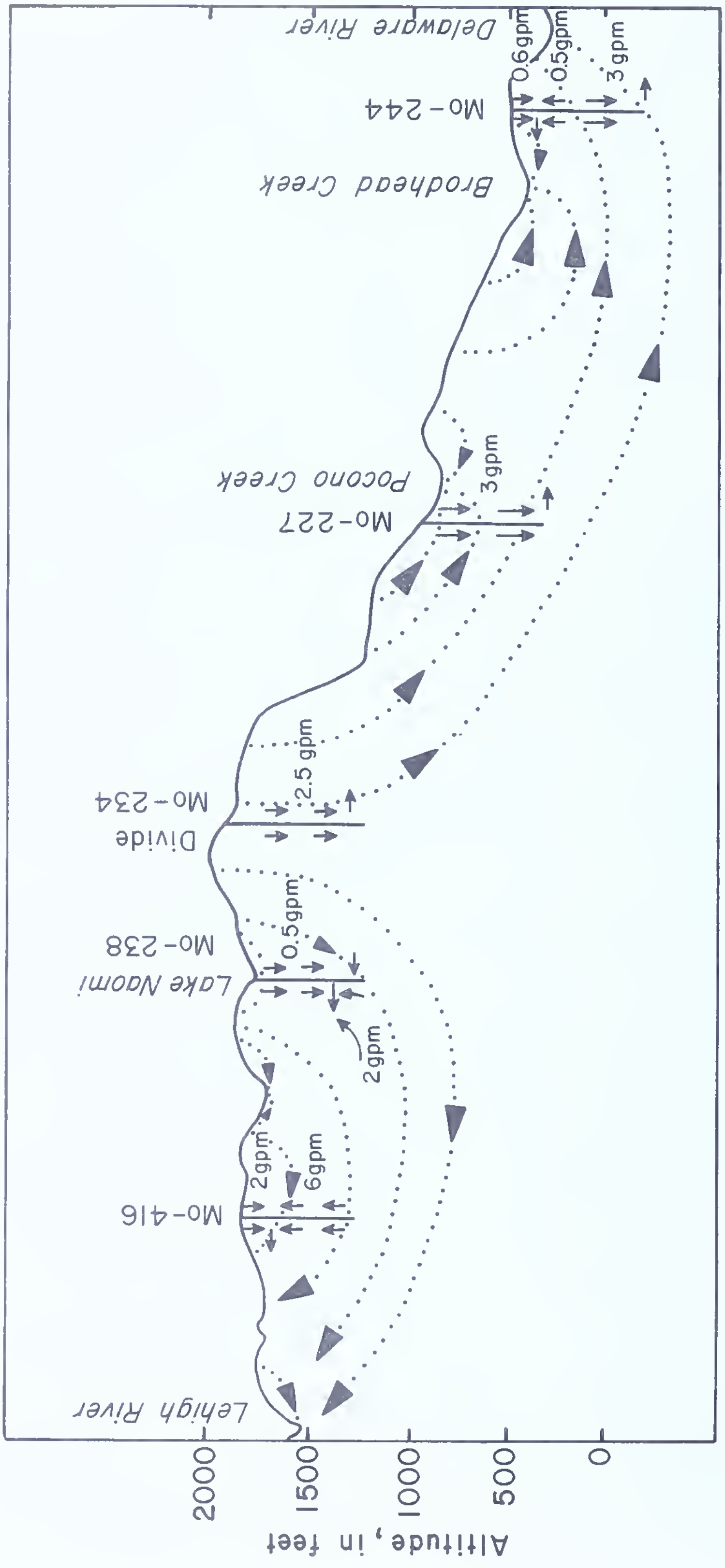

Figure 5. Diagrammatic cross section from Thornhurst to East Stroudsburg showing generalized flow paths and direction and amount of flow measured in wells. Horizontal scale is 1:250,000. Arrows indicate direction of flow; dotted lines are suggested flow lines. Wells are identified by well number.

Downward flow occurs in wells where the deep zones have lower heads than the shallow zones. Such flow occurs in wells on hilltops throughout Monroe County, particularly near groundwater divides, such as along the Pocono Plateau escarpment, Kittatinny Mountain, and Blue Mountain. Generally the deepest wells in these areas also have the deepest water levels.

Downward flow can also have a substantial effect on the amount of groundwater available to wells, if the deep zones transmit much more water than the shallow zones. The composite water level in the well is controlled by these deep zones, and may lie between 100 feet and 400 feet below the top of the zone of saturation. Such deep water levels reduce the amount of drawdown available and require more pump power to lift the water from the well. In addition, the water flowing downward, out of the well into the deep zones may be considered lost potential well yield. This loss can be minimized by setting the pump opposite the major thieving zone. The cone of depression in deep wells that have downward flow may locally dewater the upper part of the zone of saturation and cause nearby shallow wells to go dry or have a diminished yield.

Some wells that penetrate two or more flow systems (local, intermediate, or regional) may have complex flow within the borehole.The direction of flow in such wells can be upward in one part of the hole and downward in another part of the borehole (see Figure 5); however, the flow is always from higher to lower heads. In areas such as the central part of the Pocono Plateau between Pocono Pines and Trout Lake, the deeper producing zones, which may lie more than 500 feet below land surface, have a comparatively high hydraulic head. This area lies approximately midway between the highest areas of recharge, in the vicinity of the village of Tobyhanna, where altitudes may be as much as 2100 feet, and the Lehigh River, to which the groundwater flow system in the northwest part of the county drains, at an altitude of 1400 feet. Here, local relief is typically 100 feet, and comparatively minor differences in the altitude of the water table can cause a reversal of the direction of flow in wells.

Changes in Flow System

The flow of water through a well bore from a producing to a thieving zone accelerates movement of the water through the flow system by creating a short circuit in the system, and locally alters the distribution of hydraulic heads. The water level in a well that penetrates two or more producing zones having different hydraulic heads is a composite water level and is close to the head of the major producing zone. In public-supply wells that were studied, the median flow between producing and thieving zones was 1.5 gpm (2160 gpd) and the maximum flow measured was 56 gpm (80,600 gpd). The domestic wells studied had a median flow of 1 gpm (1440 gpd). These domestic wells had a median depth of 320 feet or about twice that of the average domestic well. To put some perspective on the effects on the hydrologic system by flows of this size, 1 gpm is slightly larger than the average amount of recharge per acre, which is 1200 to 1400 gpd, and considerably more water than most domestic households use in a day.

The drilling of a large number of wells, one or more per acre, may significantly alter the freshwater flow system by accelerating the movement of water down the hydraulic gradient to points of discharge and by causing local changes in potentiometric surfaces. In addition, when water nearly in equilibrium with conditions in one part of the groundwater flow system is rapidly transferred to a different part of the system, one that has different pressures, temperatures, and chemical equilibria, either deposition or solution of minerals may occur in the new environment. All such short circuits affect the system and many short circuits may significantly alter it.

WATER-BEARING ZONES

In most wells, very few zones more than 500 feet below land surface yield large quantities of water. However, drilling to depths below 500 feet may increase the yield of the wells as the surging action of the drill develops the shallower zones; that is, mud forced into these zones as they were initially penetrated is now washed out as a result of the continued drilling.

DEPTH OF FRESHWATER CIRCULATION

Fresh water probably circulates deeper than 800 feet below land surface throughout the county. Borehole-flow measurements made in deep wells (see Appendix, Table 10) indicate downward flow as deep as 700 feet.

Water temperature gradients measured in the deep wells generally approached the regional geothermal gradient at depths greater than about 400 feet below land surface. This indicates that the largest amounts of groundwater circulation occur less than 400 feet below land surface and only small amounts circulate below that depth.

AVAILABILITY

Because precipitation is abundant and relatively small amounts of water are lost to evaporation or transpiration, more water flows through the groundwater reservoir in Monroe County each year than in most other parts of the state. Average groundwater recharge is estimated at close to 1 gpm per acre or about 600 gpm/mi^2, almost twice the amount estimated for the north-central, south-central, and westernmost parts of Pennsylvania (Becher, 1970). In addition to the plentiful recharge, the depth of the freshwater circulation system appears to be as deep as, if not deeper, than that in most of the other fractured-rock areas in the state. Thus, the aquifers in

Monroe County probably store more water than similar rocks elsewhere in Pennsylvania.

Rock Type

Data in Table 4 indicate the relative capacity of the different rock types and formations to yield water to wells. The specific capacity of wells finished in the unconsolidated sand and gravel deposits is about 10 times larger than that of wells finished in the consolidated, fractured sandstones, siltstones, and shales. This difference would be greater if the wells in the unconsolidated material were finished with screens and were developed. However, most of the wells producing from the unconsolidated material have no screens and the water enters only through the open end of the casing at the bottom of the well. The average capacity of the coarse-grained and well-sorted unconsolidated rocks should be between 10 and 100 times larger than that of the consolidated rocks except for the carbonate rocks.

Despite the wide range (two orders of magnitude) in the specific capacities of wells in the fractured rocks, fairly consistent differences occur from one formation to another. Wells in the Bloomsburg Formation generally produce between three and 20 times more water than wells in the other consolidated rocks. Those in the Poplar Gap Member of the Catskill Formation are two to seven times better than the average well in the other members. The poorest wells occur in the Walcksville and Towamensing Members of the Catskill. In addition, carbonate rocks in the Devonian and Silurian, undifferentiated, unit yield more water to wells than most of the clastic rocks.

Topography

The data in Table 5 indicate a relationship between topographic position and the specific capacity of domestic wells. The highest specific capacities were obtained from wells in valleys and the lowest from wells on hilltops. Data compiled for wells in all formations show those in valleys are more than six times as productive as those on hilltops. For the Catskill Formation, wells in valleys are more than three times as productive as those on hilltops. Data are inadequate to make the same analysis for the other formations; however, the same trends seem probable.

The relationship of specific capacity to topographic position is caused by the following factors: (1) The valleys are underlain by rock that is less resistant to erosion and more permeable than the rock forming the hillsides and hilltops. (2) The saturated thickness of the unconsolidated deposits is generally greatest in the valleys and least on the hillsides and hilltops. (3) Hydraulic heads decrease with depth on hilltops and increase with depth

Table 4. *Specific Capacities of Domestic Wells in Selected Water-Bearing Rocks, Determined by One-Hour Pumping Tests*

Formation or aquifer	Number of wells	Estimated saturated thickness of the overburden (feet)	Specific capacities[1] (in gallons per minute per foot of drawdown) exceeded by indicated percentage of wells				
			90%	75%	50%	25%	10%
		Median			Median		
UNCONSOLIDATED ROCKS							
Pleistocene sand and gravel	20	74	0.45	0.78	2.85	7.0	20.0
CONSOLIDATED FRACTURED ROCKS							
Catskill Formation	101		0.04	0.08	0.22	0.67	1.63
Duncannon Member	14	—	.04	.12	.22	.50	5.0
Poplar Gap Member	19	—	.24	.35	.67	2.18	8.0
Long Run Member	62	—	.03	.06	.19	.35	1.0
Walcksville Member	18	—	.03	.04	.12	.30	1.11
Towamensing Member	10	—	.03	.06	.10	.27	.44
Trimmers Rock Formation	11		.03	.08	.18	.81	1.50
Mahantango Formation	23	12	.03	.06	.20	1.00	4.00
Marcellus Formation	25	57	.03	.07	.36	1.00	1.50
Devonian and Silurian rocks, undifferentiated	16	39	.03	.06	.38	1.50	4.00
Bloomsburg Formation	15	37	.10	1.00	2.00	5.30	16.50
All consolidated rock formations listed above	191	—	.03	.08	.26	1.00	2.82
Devonian sandstones	101	—	.04	.08	.25	.67	1.63
Devonian siltstones	32	—	.03	.06	.18	.81	3.00
Devonian shales	27	—	.03	.07	.28	.86	1.33
Devonian and Silurian carbonate rocks	10	—	.07	.20	.38	3.50	7.50

[1] Most specific capacities calculated from data reported by drillers.

— Indicates no saturated overburden.

Table 5. *Relation Between Specific Capacities of Domestic Wells and Topographic Position*

Formation or aquifer	Number of wells	Estimated saturated thickness of the overburden (feet)	Specific capacity of wells after one hour of pumping (gallon per minute per foot of drawdown)
		Median	Median
All formations			
Hilltop	37	0	0.11
Hillside	126	0	0.19
Valley	69	46	0.70
Catskill Formation			
Hilltop	23	0	0.11
Hillside	76	0	0.21
Valley	21	37	0.37

in valleys; that is, groundwater gradients are away from wells on hilltops and towards wells in valleys.

Saturated Thickness of Unconsolidated Deposits

The saturated thickness of the unconsolidated deposits was estimated to be about equal to the difference between the casing depth, which generally extends to the bedrock, and the depth to the static water level below land surface at selected well sites. The data in Table 5 show the relationship between estimated saturated thickness of the unconsolidated deposits and the specific capacity of wells, compiled by topographic position of all formations. In general, the most productive wells are those that penetrate the thickest saturated unconsolidated deposits. Plate 1 shows the location and distribution of some of the thickest unconsolidated deposits in Monroe County. The median specific capacity of the wells in the shales of the Marcellus Formation and the sandstones and siltstones of the Bloomsburg Formation would probably be lower if it were not for the large amounts of water stored in the thick saturated deposits of unconsolidated material that overlie these formations. When wells are pumped, water from these unconsolidated deposits leaks downward to replace water withdrawn from the bedrock and thereby sustains the well yields.

Pumping Rate and Duration

Long-term pumping-test data indicate that specific capacity decreases as the pumping rate or duration of pumping or both increase. The decrease in capacity as the pumping rate increases is due to an increase in the turbulence, or friction of the water entering the borehole, and, possibly, to dewatering of some of the producing zones. The effect is greater in wells in the poorer aquifers. The decrease in specific capacity between 1 hour and 24 hours of continuous pumping ranged from 11 percent for the well in the Bloomsburg Formation to 78 percent for the wells in the Catskill Formation. The average decrease for all the wells was about 57 percent.

The specific capacities of wells that are pumped continuously will decrease until (1) recharge to the groundwater reservoir has been increased by an amount equal to the pumping rate, (2) the natural discharge from the groundwater reservoir has been decreased by an amount equal to the pumping rate, or (3) the sum of the increased recharge and decreased natural discharge is equal to the pumping rate. In general, there is more opportunity both to increase recharge and decrease natural discharge close to the major streams. Because most groundwater recharge is routed to the major streams at a rate of about 600 gpm/mi^2, the largest amounts of groundwater should be available to wells near these streams. By contrast, the smallest opportunity to increase recharge and decrease natural discharge generally occurs near the basin divides. Here, both the recharge and available drainage areas are very small and all the recharge that does occur moves away from the divides. Consequently, the smallest amounts of groundwater would be available to wells drilled in these areas.

Changes in specific capacity with increasing time or pumping rate may also occur when the water level in the well is drawn below a producing zone, which then drains into the well and is no longer progressively stressed by the increasing drawdown in the well.

Thieving zones may become producing zones with increased drawdown.

When nearby wells penetrate several producing zones, some of which are in common with a pumped well and others which are not, the nearby wells may recharge the pumped well through the common zones.

ESTIMATED POTENTIAL WELL YIELD

Table 6 shows the estimated potential yield of wells in all the formations for which specific-capacity information was compiled. Properly developed and screened wells that are drilled in valley bottoms in thick deposits of sand and gravel or that penetrate major water-bearing zones deeper than 50 feet below the water table will generally have more available drawdown and, therefore, a better chance of obtaining the higher potential yields shown.

POTENTIAL EFFECT OF GROUNDWATER PUMPAGE ON STREAMFLOW

If pumpage from the groundwater reservoir exceeds the average recharge of about 650 mgd, the annual streamflow will be reduced to about one third

Table 6. *Estimated Potential Well Yield for the Major Aquifers*

Aquifer	Estimated potential yield, in gallons per minute after 24 hours of pumping[1]				
	[2]90%	75%	50%	25%	10%
Unconsolidated rocks					
Sand and gravel	25	75	200	400	750
Consolidated fractured rocks					
Catskill Formation	3	10	25	75	175
Duncannon Member	5	15	25	55	225
Poplar Gap Member	25	40	70	215	300
Long Run Member	3	7	20	40	110
Walcksville Member	3	5	15	35	120
Towamensing Member	3	7	10	30	50
Trimmers Rock Formation	3	9	25	90	160
Mahantango Formation	3	7	20	70	225
Marcellus Formation	3	7	40	110	165
Devonian and Silurian rocks, undifferentiated	3	7	30	160	300
Bloomsburg Formation	5	50	100	265	400

[1] Assuming 25 feet of available drawdown for unconsolidated rocks and 50 feet of available drawdown for consolidated fractured rocks.

[2] Percent of wells in which yield is equaled or exceeded.

of the present rate and will consist almost entirely of overland runoff. In addition, the runoff will be intermittent, and substantial amounts will occur only for short periods of time (1 to 4 days) after each storm. Groundwater withdrawals and consumption in excess of about 650 mgd would mine water from the groundwater reservoir. Current pumpage (1976) is about one percent of the recharge. The above discussion describes general conditions and assumes that groundwater withdrawals would be distributed evenly throughout the county. However, the same conditions can occur locally when groundwater withdrawal and consumption or exportation approaches and exceeds local recharge.

QUALITY

Temperature

The temperature of the groundwater varies directly with the average annual air temperature, from the highest parts of the Pocono Plateau to the lowest parts of the Delaware River valley. At depth beneath the river, the temperature of the groundwater appears to be related directly to the geothermal gradient.

Figure 6 was compiled from an analysis of 25 temperature logs of deep wells. The plots represent an average of all the water temperatures that were logged at the altitude of each point. Each point represents the temperature of the water at about 300 feet below the water table. The air temperature

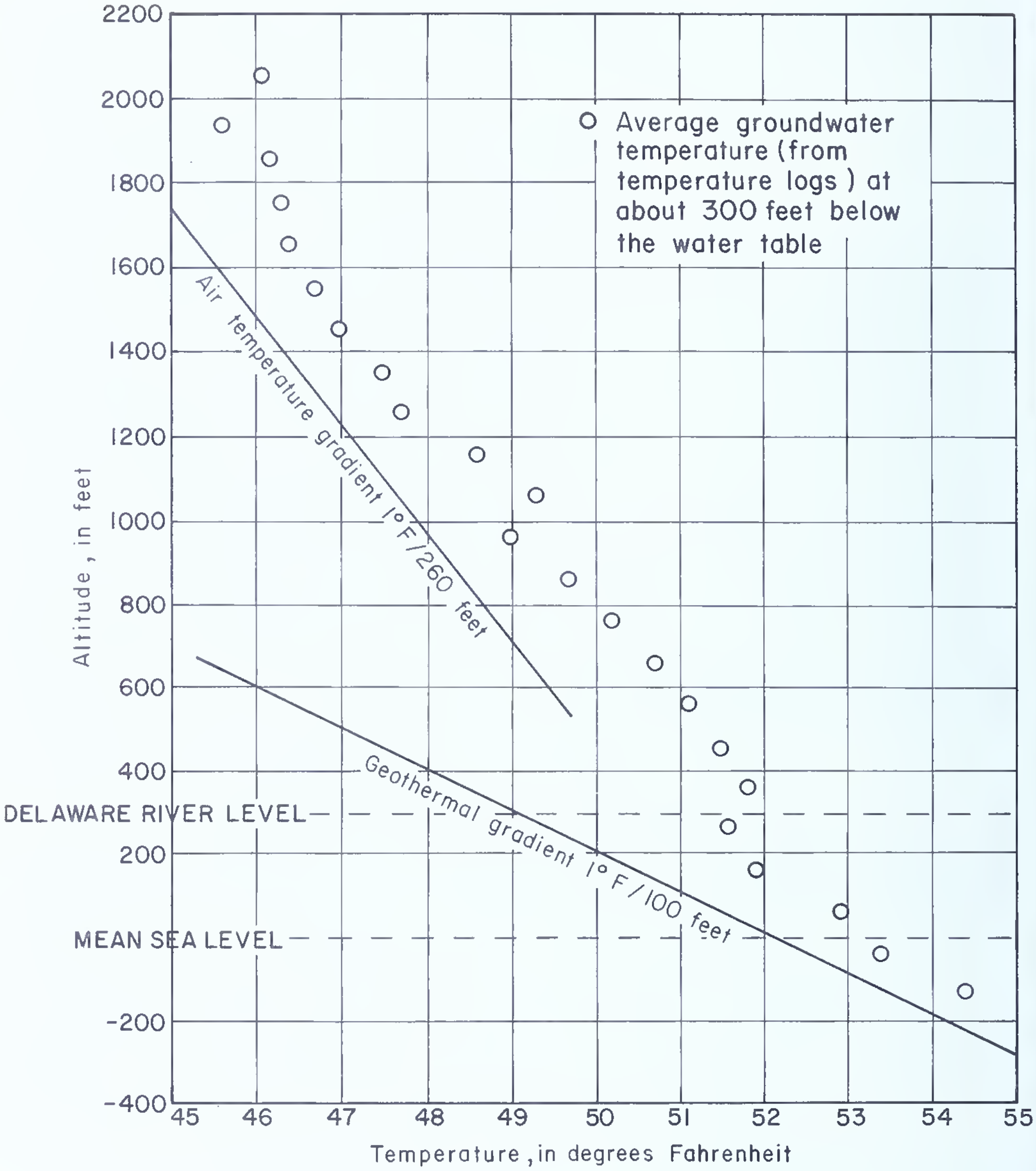

Figure 6. Groundwater temperature, air temperature, and geothermal gradients in Monroe County.

gradient (1 °F for each 260-foot change in altitude) was estimated from plots of average annual air temperatures and altitudes at Tobyhanna and Stroudsburg. The geothermal gradient (1 °F for each 100 feet of depth below the water table) was estimated from a study of temperature logs made in segments of deep wells where there was no groundwater flow.

In general, the temperature of the water 300 feet below the water table is about 1 °F warmer than the average annual air temperature at land surface.

Closer to the water table air and water temperatures will be more coincident. This temperature of groundwater near the top of the zone of saturation ranges from about 45 or 46°F where land-surface altitudes are near 2000 feet to about 52 to 54°F where land-surface altitudes are 300 to 400 feet.

Specific Conductance and Hardness

Specific conductance and hardness determinations of groundwater are summarized by formation in Table 7. The specific conductance ranged from 57 to 750 micromhos. Water from the unconsolidated deposits and from consolidated sandstones, siltstones, and shales had a median specific conductance of about 200 micromhos. The water in the carbonate rocks had a conductance of about 370 micromhos.

The total hardness ranged from 1 to 19 grains per U. S. gallon. The median hardness of water in the different noncarbonate formations ranged from 1 to 5 grains and the composite median was 3 grains per U. S. gallon; the water from the carbonate rocks had a median hardness of 8 grains per U. S. gallon.

Specific conductance can be used to estimate both the dissolved-solids content and the hardness of the water. Data from 37 wells indicate that if the specific conductance is multiplied by 0.6, the approximate dissolved-solids content is obtained; and if the conductance is divided by 40, the approximate hardness is obtained.

Chemical Analyses

The results of 58 chemical analyses of water from 45 wells are shown in Table 8. The median concentration of dissolved constituents is given by formation in Table 9.

Excessive concentrations of iron (greater than 0.3 mg/l) were found in water from 20 percent of the wells sampled in the unconsolidated deposits of sand and gravel and in the Catskill Formation. Data from the unconsolidated deposits were not sufficient to calculate the percentage of the wells that exceeded the recommended limits of manganese; however, high concentrations of manganese in these waters appears to be a common problem. The highest concentrations of iron and manganese were reported for the one well in the Shawangunk Formation.

In general, the water from all the aquifers has low concentrations of dissolved solids. Thus, wherever the dissolved-solids concentrations of water exceed about 150 to 200 mg/l in the noncarbonate aquifers, and 350 to 400 mg/l in the carbonate aquifers, contamination should be suspected.

Table 7. *Specific Conductance and Total Hardness of Groundwater*

Formation or aquifer	Total hardness as $CaCO_3$, in grains per U.S. gallon[1]			Specific conductance, in micromhos at 25° Celsius		
	Number of samples	Range of values	Median value	Number of samples	Range of values	Median value
Unconsolidated rocks						
Sand and gravel	3	2–2	2	2	75–160	117
Consolidated rocks						
Catskill Formation	24	1–5.5	3	27	60–300	160
Trimmers Rock Formation	6	2–5	3.5	6	120–215	168
Mahantango Formation	2	1–4	2.5	3	57–210	200
Marcellus Formation	4	2–9	4	3	110–390	160
Devonian and Silurian rocks, undifferentiated	8	5–19	8	9	200–750	370
Bloomsburg Formation	2	3–7	5	3	180–320	220
Shawangunk Formation	1	–	1	1	–	65
Devonian sandstones	24	1–5.5	3	27	60–300	160
Devonian siltstones	9	1–6	4	10	57–215	178
Devonian shales	5	2–9	4	4	110–390	168
Devonian and Silurian carbonate rocks	8	5–19	8	9	200–750	370

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[1] Multiply grains by 17.1 to convert to milligrams per liter.

Table 8. *Chemical Analyses of Groundwater*

(Constituents in milligrams per liter)

Aquifer: Qg, unconsolidated deposits; Dcpg, Poplar Gap Member of Catskill Formation; Dclr, Long Run Member of Catskill Formation; Dtr, Trimmers Rock Formation; Dmh, Mahantango Formation; Dm, Marcellus Formation; Dbf, Buttermilk Falls Limestone; Dsc, Schoharie Formation; Spi, Poxono Island Formation; Sb, Bloomsburg Formation; Ss, Shawangunk Formation.

Data source: U, U. S. Geological Survey; C, commercial laboratory.

Well number	Date of collection	Aquifer	Data source	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate as nitrogen (N)	Phosphate (PO_4)	Sum of dissolved constituents	Total hardness (as $CaCO_3$)
MONROE COUNTY																		
Mo-4	12/17/53	Dcpg	U	4.7	0.04	—	4.0	1.0	—	1.8	14	1.0	3.0	0.0	0.4	—	29	17
	12/28/53	Dcpg	U	4.3	0.03	—	4.0	1.0	—	1.9	14	1.0	3.5	.0	.2	—	24	17
	7/03/57	Dcpg	U	5.1	.26	—	4.0	.5	—	2.3	11	3.3	1.3	.1	.6	—	29	15
	12/18/60	Dcpg	U	5.6	.36	—	2.8	1.5	—	1.4	7	7.7	.8	.0	.5	—	26	20
	3/13/62	Dcpg	U	7.1	.02	—	2.9	1.5	.9	.5	12	.6	1.9	.0	.7	—	25	17
	11/19/63	Dcpg	U	5.1	.14	.02	2.0	1.0	—	1.6	10	.4	1.9	.0	.8	—	21	10
5	12/18/58	Dcpg	U	6.0	.73	.0	4.4	1.2	—	1.6	12	2.0	2.2	.0	1.6	—	32	22
	3/13/62	Dcpg	U	7.1	1.0	.01	3.7	1.9	1.8	.5	10	1.9	3.8	.1	1.6	—	34	26
	11/19/63	Dcpg	U	5.4	.11	.02	6.4	1.9	2.0	.0	13	.4	8.1	.1	1.6	—	38	37
	10/21/69	Dcpg	U	5.0	.04	.01	4.9	1.8	2.0	.5	10	3.3	6.0	.0	1.8	—	36	31
6	7/03/57	Dcpg	U	10	.49	.0	22	3.0	—	3.2	77	6.3	1.6	.0	.8	—	86	71
	12/18/58	Dcpg	U	7.8	.06	.0	21	3.6	—	2.5	78	5.5	1.2	.0	.5	—	83	70
	8/24/60	Dcpg	U	7.9	.04	.0	31	3.0	2.8	.5	110	5.0	2.6	.0	.9	—	111	90
	8/06/64	Dcpg	U	7.1	.03	—	22	3.4	2.6	.5	78	5.0	2.9	.1	.6	—	85	74
9	9/22/30	Dcpg	U	—	—	—	3.0	—	2.0	—	10	2.0	3.0	—	1.4	—	—	—
18	9/22/30	Dcpg	U	—	—	—	5.0	—	—	—	20	2	1.0	—	.2	—	—	—
46	7/03/57	Dcpg	U	4.5	.01	.0	10	1.0	—	3.9	26	5.8	2.5	.1	1.7	—	47	37
	8/24/60	Dcpg	U	6.0	.1	.0	7.3	2.3	2.0	.5	26	5.0	2.0	.0	1.2	—	43	34
49	9/23/30	Dm	U	—	—	—	36	4.9	—	6.0	109	26	5.0	—	.0	—	—	131
67	9/23/30	Qg	U	—	—	—	10	—	—	7.0	42	4.0	1.0	—	.0	—	—	—
70	9/23/30	Dm	U	11	.05	—	9.2	2.1	4.0	.2	24	14	1.8	—	.4	—	56	44
127	9/22/30	Qg	U	—	—	—	3.0	—	—	2.0	11	2.0	1.0	—	.02	—	—	—
190	10/08/68	Qg	U	5.9	4.6	.19	3.3	.7	.8	.3	10	.9	2.5	—	.04	0.0	24	14
191	12/04/68	Dsc	U	10	.27	.01	21	3.9	5.2	.8	72	20	1.4	.0	.0	—	98	79
199	9/28/70	Ss	U	5	6.2	.43	2.3	3.0	1.5	4.6	12	12	2.2	.3	.0	—	37	26
202	5/25/71	Ds	U	7.4	.10	.02	32	2.6	3.0	1.8	84	34	1.2	.1	.07	.0	124	113

Table 8. *(Continued)*

Well number	Date of collection	Aquifer	Data source	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate as nitrogen (N)	Phosphate (PO_4)	Sum of dissolved constituents	Total hardness (as $CaCO_3$)
MONROE COUNTY																		
204	3/06/73	Dmh	U	9.5	—	—	6.1	1.6	2.0	.2	21	5.5	1.5	.1	—	—	37	27
205	9/19/72	Dmh	U	—	—	—	—	—	—	.55	—	—	—	—	1.8	—	—	—
211		Qg	U	—	—	—	—	—	—	—	35	—	2.0	.0	.6	—	46	40
218	9/18/69	Sb	C	—	.25	.0	9.4	4.6	—	—	60	.0	1.0	.6	.0	—	61	—
228	12/04/48	Dclr	C	—	1.8	—	—	—	—	—	52	—	5.0	—	1.1	—	—	46
230		Dcpg	C	—	.0	.0	—	—	—	—	27	—	1.0	.0	.0	—	54	32
231	3/22/65	Dclr	C	—	.0	—	—	—	—	—	51	—	1.0	—	—	—	76	34
234	8/20/71	Dcpg	C	—	—	—	25	—	—	—	115	58	5.0	—	.07	—	124	84
235	6/14/73	Dcpg	C	7.0	.53	.05	13	2.9	1.0	.2	71	4.0	2.0	.25	.21	—	—	44
236	7/09/73	Dcpg	C	8.0	.21	.05	—	—	—	.02	68	20	4.0	.32	.15	—	—	60
243	2/18/71	Dbf	C	—	.0	.0	—	—	—	—	185	38	5.0	—	.59	—	248	176
	4/23/71	Dbf	C	—	.02	.0	—	—	—	—	156	29	5.0	—	.41	—	198	160
244	2/06/71	Dbf	C	—	.0	.0	—	—	—	—	198	38	9.5	—	.40	—	276	202
246	4/15/71	Sp	C	—	1.0	.0	—	—	—	—	122	77	10	—	.28	—	390	234
PIKE COUNTY																		
Pi-200	1/03/72	Dtr	C	—	.11	.05	—	—	—	—	32	1.0	2.0	.1	.1	—	55	33
201	12/15/72	Dtr	C	—	.05	.07	—	—	—	—	98	5.0	1.0	—	.1	—	123	86
202	10/06/72	Qg	C	—	.1	.1	—	—	—	—	30	1.0	4.0	—	.1	—	116	29
203	10/13/72	Dmh	C	—	.1	.1	—	—	—	—	99	—	6.0	—	.1	—	131	64
204	11/15/72	Dtr	C	—	.13	.16	—	—	—	—	112	2.0	4.0	—	.1	—	112	56
205	11/02/72	Dtr	C	—	.05	.06	—	—	—	—	76	2.0	1.0	—	.1	—	108	68
206	12/28/72	Dtr	C	—	.10	.05	—	—	—	—	102	—	—	.1	.1	.03	118	71
207	9/28/72	Dcpg	C	—	.1	.1	—	—	—	—	105	8.0	3.0	—	.1	—	—	90
208	9/27/72	Dcpg	C	—	.1	.1	—	—	—	—	126	6.0	9.0	—	.1	—	—	64
WAYNE COUNTY																		
Wn-116	7/13/72	Dcpg	C	14	.06	.05	2.9	7	4.9	.5	134	20	2.0	.25	.15	—	—	103
117	6/01/73	Dcpg	C	8.4	.09	.05	26	2	4.2	1.2	107	1.0	6.0	.44	.18	—	—	103
119	1/18/73	Dcpg	C	—	.12	.05	—	—	6.1	—	105	10	4.0	—	.1	—	124	96
120	1/26/73	Dcpg	C	—	.1	.05	—	—	1.0	—	87	7.0	6.0	—	.15	—	141	88
121	4/16/73	Dcpg	C	—	.06	.09	—	—	4.3	—	102	10	4.0	—	.1	—	119	110
122	4/05/73	Dcpg	C	—	.1	.05	—	—	3.1	—	105	7.0	4.0	—	.1	—	118	90
123	5/18/73	Dcpg	C	.1	.1	.05	11	2	24	.85	117	1.0	8.0	.01	.06	—	—	38
124	2/15/73	Dcpg	C	—	.1	.05	—	—	5.5	—	76	5.0	2.0	—	.1	—	110	64

Table 9. *Median Concentration of Dissolved Constituents in Groundwater*

(Concentrations in milligrams per liter)

Formation or aquifer	Number of samples	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Sum of dissolved constituents
Unconsolidated rock															
Sand and gravel	5	5.9	2.3	.15	7	—	—	2	11	1.5	2	—	.1	—	70
Consolidated rock															
Catskill Formation[1]	35	6	.05	.02	5	1.9	2.8	.7	14	5	3	.1	2.8	—	100
Trimmers Rock Formation	5	—	.1	.07	—	—	—	—	—	2	1.5	.05	.1	—	112
Mahantango Formation	3	9.5	—	—	6.1	1.6	2	.02	21	5.5	3.7	.1	4	.55	85
Marcellus Formation	2	11	—	—	23	3.5	4	3	67	20	3.5	—	.9	—	—
Devonian and Silurian rocks, undifferentiated															
Carbonates[2]	4	—	.02	.0	—	—	—	—	—	38	7	—	—	—	260
Noncarbonates[3]	2	8.5	.18	.02	26	3.2	4.1	.9	78	27	1.3	.05	.15	—	111
Bloomsburg Formation	1	—	.25	.00	9.4	4.6	—	—	—	.0	1	.6	.0	—	61
Shawangunk Formation	1	5	6.2	.43	2.3	3	1.5	4.6	12	12	2.2	.3	.00	—	53

[1] Most analyses are of water from the Poplar Gap Member.

[2] Analyses are of water from the Buttermilk Falls and Poxono Island Formations.

[3] Analyses are of water from the Esopus and Schoharie Formations.

SUMMARY

The average annual precipitation in Monroe County is 45 inches, of which 27 inches leaves the area as streamflow, and 65 percent of this streamflow is water that has moved through the groundwater reservoir. Evaporation and transpiration consume 18 inches of the precipitation.

Water is stored and transmitted through intergranular openings in the unconsolidated rock and in joints, fractures, and solution openings in the consolidated rock. The unconsolidated deposits of sand and gravel store 70 billion gallons of water or about 10 times as much as they receive as direct recharge each year. The freshwater flow system in the consolidated rocks locally extends to depths of more than 800 feet and stores 1 trillion gallons of water or five times the annual groundwater discharge.

There are local, intermediate, and regional flow systems. Most of the annual recharge is transmitted through the local systems to nearby streams and comparatively small amounts pass through the intermediate and regional flow systems.

Wells in the consolidated rocks act as short circuits within and between flow systems. Water flows through the well from producing zones of higher hydraulic head to those of lower head. The flow may be up or down the well or upward in one part of the well and downward in another part. The effect of the flow is to accelerate the movement of water towards points of discharge, redistribute hydraulic heads, change the top of the zone of saturation in the vicinity of the well, and transfer water rapidly from one environment to another. The short-circuited flow of 1 gpm is equal to more than the daily recharge of an acre of land. Most of the wells in which borehole velocity measurements were made had flows in excess of 1 gpm.

The specific capacity of wells drilled in valleys averages six times that of wells on hilltops. Deep wells drilled in the uplands near large topographic breaks penetrate producing zones having hydraulic heads as much below the top of the zone of saturation. Because of the extra lift required, the cost of producing water from these zones having the comparatively low heads is much greater than from shallow zones whose hydraulic heads are close to that of the local water table. Current pumpage of groundwater is about one percent of recharge.

Groundwater temperatures range from 45°F for water from shallow depths on the Pocono Plateau to 57°F for water deep in the flow system near the Delaware River. The water temperature is directly related to the mean annual air temperature, which decreases with increasing altitude. Hardness of water in the noncarbonate rocks averages 3 to 4 grains per gallon, or about half that of the carbonate rocks. Water from most of the bedrock aquifers is low in dissolved solids; it is acidic and soft. In carbonate rocks, the water tends to be hard and slightly alkaline. Excessive amounts of iron and manganese occur in water from the unconsolidated deposits and, locally, in water from the Catskill and Shawangunk Formations.

Assuming 24 hours of pumping and 50 feet of drawdown, one of every four wells constructed for large yields will produce 250 gpm from the Bloomsburg, 160 gpm from the Devonian and Silurian, undifferentiated, unit, 110 gpm from the Marcellus, 75 gpm from the Catskill, 90 gpm from the Trimmers Rock, and 70 gpm from the Mahantango. Assuming 24 hours of pumping and 25 feet of drawdown, one of every four wells constructed for large yields will produce 400 gpm from the unconsolidated sand and gravel.

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FACTORS FOR CONVERTING ENGLISH UNITS TO METRIC UNITS

Factors are shown to four significant figures.

English	*Multiply by*	*Metric*
acres	2.4710	ha (hectares)
feet	3.048×10^{-1}	m (meters)
gallons	3.785	l (liters)
gpd (gallons per day)	4.381×10^{-5}	l/s (liters per second)
gpm (gallons per minute)	6.308×10^{-2}	l/s (liters per second)
inches	2.540×10^{1}	mm (millimeters)
miles	1.609	km (kilometers)
mi^2 (square miles)	2.590	km^2 (square kilometers)
mgd (millions of gallons per day)	4.381×10^{1}	l/s (liters per second)
million gallons	3.785×10^{-3}	hm^3 (cubic hectometers)

GLOSSARY

Anticline. A fold in rocks in which the strata dip outward away from the axis of the fold. Opposite of *Syncline.*

Aquifer. A formation, group of formations, or part of a formation from which water is collectible in usable quantities.

Bedding. Layers of sedimentary rocks of the same or different lithology.

Bedrock. A general term for the rock, usually solid, that underlies soil or other unconsolidated or semiconsolidated surficial material.

Carbonate rocks. Rock composed primarily of minerals that contain the carbonate radical (CO_3^{-2}). In the study area the rocks are limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$).

Cleavage. Breaks or splits in rock along definite, parallel, closely spaced planes; may be highly inclined to the bedding planes.

Colluvium. A general term applied to loose and incoherent deposits, usually at the foot of a slope or a cliff and brought there chiefly by gravity.

Deformation. Any change in the original form or volume of rock masses produced by earth forces; folding, faulting, and solid flow are common modes of deformation.

Dip. The angle at which a bed or any planar feature is inclined from the horizontal.

Fault. A surface or zone of fracture in rock along which movement has taken place.

Fracture. A general term for any break in rock due to mechanical failure by stress, including cracks, joints, and faults.

Fracture traces. Fracture traces are natural linear features consisting of topographic (including straight stream segments), vegetational, or soil-tonal alignments, which are visible primarily on aerial photographs, and are expressed continuously for less than a mile.

Geothermal gradient. The temperature gradient in the outer part of the earth's crust, which is about 1 °F for each 100 feet in depth. Movement of water through the freshwater flow system alters the thermal gradient, and movement of water in wells often completely obscures the gradient.

Groundwater. That part of the subsurface water in the zone of saturation.

Groundwater discharge. Release of groundwater in springs, seeps, or wells from the groundwater reservoir.

Groundwater recharge. Addition of water to the groundwater reservoir by infiltrating precipitation or seepage from streambeds.

Groundwater reservoir. See *Aquifer.*

Hydraulic conductivity (or Permeability). The capacity of a porous rock, sediment, or soil to transmit a fluid without impairment of the medium; it is a measure of the relative ease of fluid flow under pressure.

Joints. Fractures in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.

Lithology. A term meaning the description of rocks. Also meaning the composition and texture of rocks.

Permeability. See *Hydraulic conductivity.*

Porosity. The ratio of the aggregate volume of interstices in a rock or soil to its total volume. It is usually stated as a percentage.

Reported well yield. The short-term discharge of a well as reported by well drillers in gallons per minute.

Saturated zone. That part of the water-bearing material in which all voids are completely filled with water under pressure equal to or greater than atmospheric.

Sericite. A variety of the mica muscovite.

Solution cavity. Any void, generally an enlargement in the fracture opening, caused by solvent action of water in limestone or dolomite.

Specific capacity. The yield of a well, in gallons per minute, divided by the drawdown of water level in the well, in feet, for some specific period of pumping.

Specific conductance. Specific conductance is a measure of the capacity of a substance to conduct electrical current. It is measured in micromhos per centimeter and is equal to 10,000 divided by the electrical resistivity, in ohm meters. Waters having small amounts of dissolved solids have low conductances whereas waters having comparatively large amounts of dissolved solids have high conductances.

Static water level. The water level in a well when the well is not being pumped and when the water level is unaffected by any prior pumping of the well or nearby wells.

Storage coefficient. The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Structure. The sum of the attitudes, arrangements, or relative positions of the rocks (features produced in the rock by movements after deposition, and commonly after consolidation of the rock) of an area.

Surface water. That water on the surface of the earth. Surface water is generally a combination of overland runoff and groundwater discharge, the proportions varying from almost 100 percent overland runoff during periods of high intensity rain to 100 percent groundwater discharge during periods of little or no rain.

Syncline. A fold in the rocks in which the strata dip toward the axis. Opposite of *Anticline.*

Terminal moraine. A deposit of unsorted sediments formed across the course of a glacier at its farthest advance.

Till. Nonsorted, nonstratified material, ranging in size from clay to boulders; carried or deposited directly by ice.

Transmissivity. The rate at which water of prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Water table. That surface is an unconfined groundwater body at which the pressure is atmospheric.

Zone of saturation. The zone below the water table in which all openings are saturated.

APPENDIX

GEOPHYSICAL LOGS AND PACKER TESTS

Geophysical logs were made for 35 wells in Monroe County and adjacent parts of Pike and Wayne Counties. Locations of these wells are shown on Figure 7, and Table 10 indicates the type of logs made and identifies the wells in which packer tests were made. Table 11 shows the result of the packer tests. The geophysical logs were temperature, fluid conductivity, caliper, electric, gamma ray, neutron, and borehole velocity. These logs and their application to the study of groundwater are briefly described in the following paragraphs.

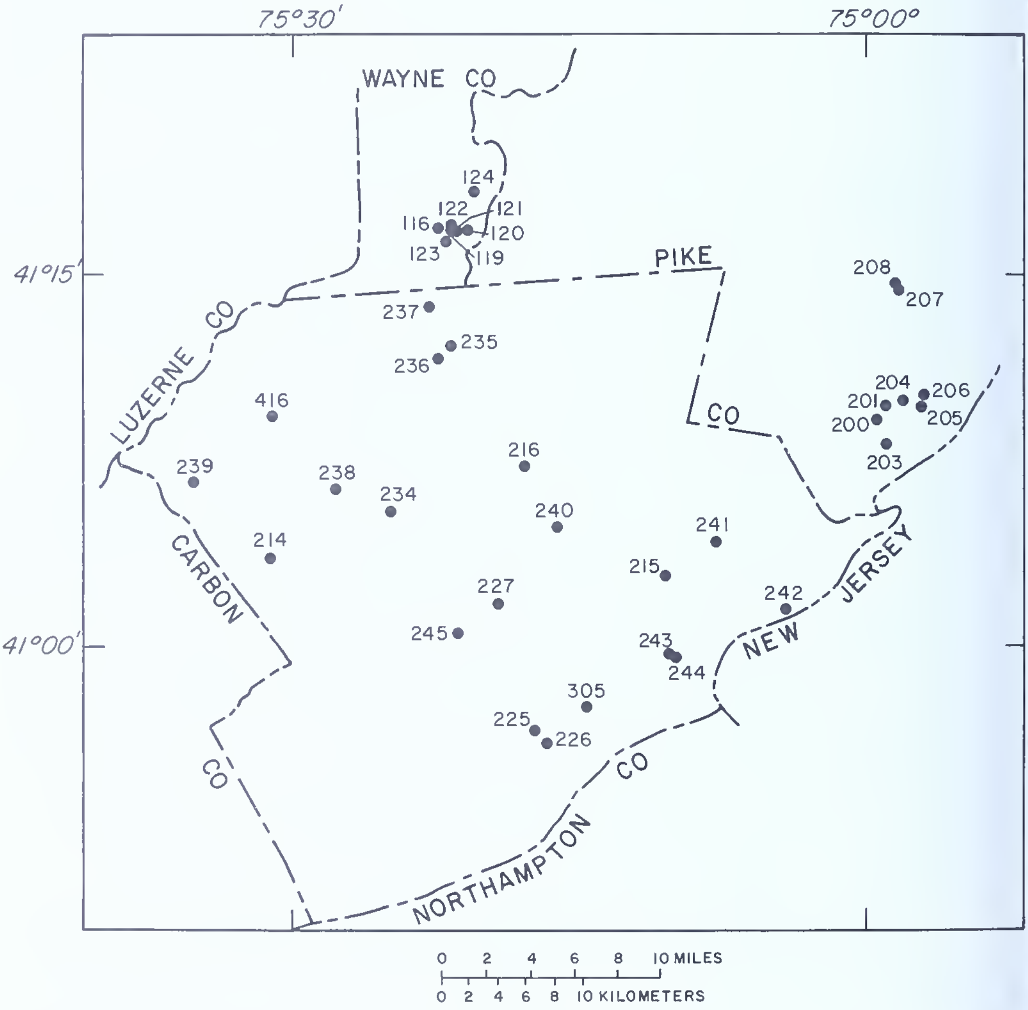

Figure 7. Location of wells in which geophysical logs and packer tests were made in Monroe County and parts of Pike and Wayne Counties.

Table 10. *Geophysical Logs and Packer Tests*

Well number	Mo-214	Mo-215	Mo-216	Mo-225	Mo-226	Mo-227	Mo-234	Mo-235	Mo-236	Mo-237	Mo-238	Mo-239	Mo-240	Mo-241	Mo-242	Mo-243	Mo-244	Mo-245	Mo-305	Mo-416	Wn-116	Wn-119	Wn-120	Wn-121	Wn-122	Wn-123	Wn-124	Pi-200	Pi-201	Pi-203	Pi-204	Pi-205	Pi-206	Pi-207	Pi-208
Well depth	290	170	223	524	421	655	697	616	346	568	575	170	224	1052	420	720	705	324	572	534	540	750	759	652	505	526	323	799	789	804	459	684	458	609	804
LOGS																																			
Temperature	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fluid conductivity	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Caliper		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Electric				X		X	X	X	X	X				X	X		X	X		X	X	X	X	X	X	X	X	X	X		X	X		X	X
Gamma	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Neutron	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Borehole velocity	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Packer tests				X					X		X		X			X	X		X			X	X	X	X	X		X							

Table 11. *Results of Packer Tests*

Well number	Altitude of land surface (feet above mean sea level)	Well depth (feet)	Flow in well [1] (gpm)	Composite water level below land surface (feet)	Packer setting below land surface (feet)	Duration of test [2] (minutes)	Change in water level Above packer (feet)	Change in water level Below packer (feet)	Specific capacity (gallons per minute per foot of drawdown) Above packer	Specific capacity (gallons per minute per foot of drawdown) Below packer
Mo-227	990	655	.3-.4↓	125	215	120	+4.24	−2.33	0.16	0.13
Mo-236	1,985	346	5.0↑	12	176	40	−0.5	+1.38	10	3.6
Mo-238	1,790	575	0.5↓	3.6	240	20	−0.11	0		
					140	20	−0.28	+.03		
Mo-243	530	720		93	105	75	+0.56	0		
Mo-244	520	705	0.6–0.8↕	66	100	480	+9.30	−0.44		
					280	120	−0.15	+0.25		
Mo-416	1,785	534	4.0↑	41.1	120	120	−5.76	+10.17	0.66	0.39
Wn-119	1,820	750	0.3↓	56.7	110	135	+1.54	−0.02		
			0.4↓	56.7	270	125	+1.8	−0.08		
Wn-120	1,860	759	2 ↓	13.5	120	130	+1.45	−1.05		
				13.5	160	23	+0.5	−136.1	2.67	0.01
Wn-121	1,780	652	1–2 ↓	17.0	210	60	+1.75	−1.2	0.57	1.66
Wn-122	1,740	505	2–0.5↑	2.7	120	80	−2.45	+4.71	0.82	0.25
Wn-123	1,900	526	12 ↓	90	220	120	+70	−5.2	0.17	3.0
Pi-200	1,180	799	2.0 ↓	25	120	110	+2.4	−9.0	0.83	0.22

[1] Arrow indicates direction of flow: ↓ down, ↑ up. Flow recorded at packer installation depth before packer was installed.

[2] Tests were not run long enough for water levels to come to equilibrium.

For more detailed information on logging, the reader is referred to "Application of borehole geophysics to water-resources investigations," by Keys and MacCary (1971).

Caliper: The caliper log gives a continuous record of borehole size. These logs are useful in determining the location and extent of openings in the sides of the borehole caused by caving, fracturing, and solution.

Electric: (1) Electric resistivity logs form a continuous record of the resistance to the flow of an electrical current from points within the borehole to an electrical ground at land surface. Sandstone units containing fresh water have a high resistance, shales a low resistance. This log is useful for determining lithology and stratigraphic correlations and the presence of water-producing fractures in rocks of low porosity.

(2) Spontaneous potential logs record small differences in voltage that develop at the contacts of the borehole fluid, the shale or clay, and the water in the aquifer. The logs are used for determining lithology, chiefly shale and clay content.

Fluid conductance: Fluid-conductance logs record the conductivity of the water in the borehole. Changes in conductivity readings reflect differences in the dissolved solids in the water and, therefore, indicate changes in chemical quality of the water in the well. Because water in different producing zones is often of different quality, the logs help to define producing zones.

Gamma: Natural-gamma logs indicate the amount of natural gamma radiation given off by the rocks surrounding the borehole. In general, shales give off more radiation than sandstones or carbonate rocks, typically because of their potassium content. Consequently, the logs are useful in determining lithology and in making stratigraphic correlations.

Neutron: Neutron logs are made by lowering a neutron source and detector into the borehole. Hydrogen atoms slow the neutrons so that they are captured by other elements. In zones in the borehole where the surrounding rock is porous and saturated, more neutrons are captured and fewer neutrons reach the detector. The logs are useful in determining differences in porosity in the rocks surrounding the borehole.

Temperature: Temperature logs record the temperature throughout the borehole. This is possibly the most useful type of log in that it outlines producing and thieving zones and, in conjunction with local knowledge of temperature gradients, indicates the direction of flow of water in the borehole. Where flow occurs in a well that penetrates water-bearing zones having different heads, it is indicated by slopes steeper than 1°F per 100 feet. In general, the flow of water in the well distorts the temperature log so as to mask the changes in conductance of heat to be expected between rocks of different lithological composition.

Velocity: Borehole velocity measurements were made by injecting a concentrated solution of electrolyte (table salt) into the well and tracing its movement by repeatedly running fluid-conductance logs and recording the time of travel of the peak of the anomaly caused by the brine. These measurements help define producing zones and intervals in wells where flow takes place. They also can be used in conjunction with test pumping to outline producing zones and to determine the percent of total yield produced from each individual zone.

Packer tests: Packer tests were made in 12 wells by lowering a packer to depths that had been selected by geophysical logging, and inflating the packer. The packer consists of a steel cylinder covered with a rubber sleeve which is inflatable with nitrogen gas. Measurements were made of the water levels above and below the packer prior to and after inflation. Because of physical limitations of the equipment, the packer could not be placed much more than 200 feet below the static water level in any well. Thus, in most cases, only heads in the upper part of the flow system were measured.

In summary, each geophysical log measures a different characteristic of the rocks surrounding the borehole or the water in and near the borehole. In general, each log adds information valuable in the interpretation of the other logs, and the hydrologic system penetrated by the borehole. Temperature, fluid-conductance, electric, neutron, and caliper logs often indicate producing and thieving zones in boreholes. The borehole velocity logs show the direction and amount of water movement in the borehole. Packer tests indicate the head differences in the hydrologic system penetrated by the borehole; those head differences control the direction and amount of movement.

TABLE 12. RECORD OF WELLS

Well location: Lat-long, latitude and longitude, in degrees and minutes, of the southeast corner of a 1-minute quadrangle within which the well is located.

Owner: C-45, C indicates composite well. The numeral indicates the number of wells used in the composite. See explanation on Plate 1 for further information.

Use: C, commercial; H, domestic; N, industrial; P, public supply; R, recreational; S, stock; T, institution; U, unused; Z, fish hatchery.

Altitude of land surface: Estimated from topographic maps with a 20-foot contour interval. Datum is mean sea level.

Topographic setting: H, hilltop; S, hillside; V, valley; T, terrace; L, swamp; U, undulating; unknown where no symbol is given.

Aquifer: Qg, unconsolidated deposits; Dc, Catskill Formation; Dcd, Duncannon Member; Dcpg, Poplar Gap Member; Dcp, Packerton Member; Dclr, Long Run Member; Dcbr, Beaverdam Run Member; Dcw, Walcksville Member; Dct, Towamensing Member; Dtr, Trimmers Rock Formation; Dmh, Mahantango Formation; Dmr, Marcellus Formation; DSu, Devonian and Silurian formations, undifferentiated; Dbf, Buttermilk Falls Limestone; Dsc, Schoharie Formation; Des, Esopus Formation; Dhg, Helderberg Group; Dco, Coeymans Formation; Spi, Poxono Island Formation; Sb, Bloomsburg Red Beds; Ss, Shawangunk Formation.

Lithology: cg, conglomerate; ls, limestone or dolomite; rb, red beds; sdgv, sand and gravel; sh, shale; st, siltstone; ss, sandstone; wr, weathered bedrock.

Static water level: Depth--F, flows but head is not known; +, measurement is in feet above land surface. Date--month/last two digits of year.

Reported yield: gpm, gallons per minute.

Specific capacity: gpm/ft, gallons per minute per foot of drawdown.

Hardness: gpg, grains per gallon.

Specific conductance: Deg C, degrees Celsius.

TABLE 12.

Well location		Owner	Driller	Date completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer/lithology
Number	Lat-Long							
								MONROE
Mo- 1	4101-7530	U. S. Forest Service	---	1948	U	1933	S	Dcpg/ss
2	4101-7531	do.	---	1948	U	1898	V	Dcpg/ss
3	4101-7532	do.	---	1948	U	1792	V	Dcpg/ss
4	4111-7525	Tobyhanna Army Depot 2	---	1944	P	2016	H	Dcpg/ss
5	4111-7525	Tobyhanna Army Depot 3	Isaac Berger	1954	P	1917	H	Dcpg/ss
6	4111-7525	Tobyhanna Army Depot 4	---	1955	P	2006	H	Dcpg/ss
9	4110-7525	Tobyhanna Water Co.	---	---	P	1960	H	Dcpg/ss
13	4106-7529	Ephriam Hay	Jesse Rausberry	---	H	1680	V	Dcpg/ss
15	4106-7528	Pocono Lake Hotel	Isaac Berger	---	H	1751	V	Dcpg/sh
17	4106-7527	Luther Land Assoc.	Hawk Drilling	---	H	1800	H	Dcpg/ss
18	4106-7527	Pocono Pines Miller	---	---	R	1780	V	Dcpg/ss
23	4104-7519	L. L. Rhodes	---	---	H	---	S	Qg/sdgv
27	4107-7516	---	---	---	H	---	S	Qg/sdgv
28	4108-7517	Wilmer Tea Room	Hawk Drilling	---	H	---	V	Dclr/sdgv
35	4111-7515	Belcher	Belcher	---	H	992	V	Dclr/ss
44	4110-7525	J. K. Wismer and Son	Hawk Drilling	---	H	1905	V	Dcpg/ss
45	4110-7525	F. Micelli	do.	---	H	---	V	Dcpg/ss
46	4111-7525	Tobyhanna Army Depot No. 1	do.	1953	P	1990	H	Dcpg/ss
48	4056-7518	Calvin Smith	Allen	---	H	530	V	Dm/sh
49	4156-7517	Monroe County Home	---	---	T	500	V	Dm/sh
63	4055-7523	W. Fehr	---	---	H	---	V	Dm/sh
64	4055-7523	---	Allen	---	H	---	V	Dm/sh
67	4054-7525	Weir Lake Creamery	Ed Arner	---	N	722	V	Qg/sdgv
70	4053-7519	Hamilton Water Co.	M. B. Biery	---	P	690	V	Dm/sh
72	4051-7518	Blue Mountain Consolidated Water Co.	---	1904	P	880	V	Sb/rb
73	4051-7518	do.	---	1904	P	840	V	Sb/rb
74	4051-7518	do.	---	1904	P	840	V	Sb/rb
80	4053-7518	Keystone Clay Works	Allen	---	N	---	H	DSu/sh
90	4057-7517	M. S. Harps	do.	---	H	510	V	Dm/sh
107	4142-7507	N. Huffman	do.	---	H	---	V	Dbf/ls
113	4102-7501	W. R. Webb	Isaac Berger	1912	H	345	V	Spi/ls
122	4112-7514	S. Shaverly	Allen J. Greening	---	H	---	H	Dclr/ss
127	4105-7535	Harrison	Hawk Drilling	---	H	1567	V	Qg/sdgv
141	4059-7511	Indian Queen Hotel	---	---	H	---	T	Dm/sh
153	4055-7522	Ruth Serfass	Mel Fehr & Gil. Overpeck	---	H	720	V	Qg/sdgv
154	4104-7502	Catherine McAuliffe	Hawk Drilling	---	H	470	T	Qg/sdgv
155	4111-7515	W. Vernoy	Ervin R. Bush	1955	H	940	V	Dclr/ss
158	4107-7518	Claus Dumbon	Hawk Drilling	1955	H	1160	V	Dclr/ss
159	4102-7518	Alfred Learn	Ervin R. Bush	1957	H	900	V	Dclr/ss
160	4102-7518	George Zehner	do.	1957	H	900	V	Dclr/ss
161	4054-7529	Leroy Keller	Albert O. Meckes	1953	H	690	V	Dm/sh
162	4052-7519	John Jacob	Anthony P. Tomsic	1950	H	720	S	Sb/rb
163	4055-7517	F. L. Kemmerer	---	1916	S	---	V	Qg/sdgv
165	4055-7516	Leo Coloaugh	---	1956	H	680	T	DSu/--
166	4056-7514	G. L. Heller	Ervin R. Bush	1951	H	---	V	Sb/rb
167	4056-7514	R. Haney	Kohl Bros., Inc.	---	H	---	V	Sb/rb
168	4057-7511	Harry Williams	Ervin R. Bush	---	H	325	V	Spi/ss
169	4057-7511	Henry Wells	do.	---	H	320	V	Spi/sh
170	4058-7509	Charles Moyer	do.	1954	H	400	V	Spi/ls
171	4100-7506	Minard Flor	do.	1956	H	340	V	DSu/ls
172	4102-7502	Blanchard Michael	Edward Broad	1939	H	---	S	Spi/sh
173	4102-7501	John Farrington	Ervin R. Bush	---	S	480	S	Spi/sh
174	4102-7501	do.	---	---	H	350	S	Spi/sh
175	4102-7501	do.	Ervin R. Bush	---	H	400	S	Spi/sh
176	4103-7503	Floyd Dickison	Albert O. Meckes	1956	H	480	V	Dm/sh
181	4054-7525	A. Meckes	do.	1955	H	710	V	Dm/sh
182	4100-7516	Atlantic	Ervin R. Bush	1952	H	900	S	Dtr/st
185	4051-7518	Blue Mountain Consolidated Water Co.	Harrisburg's Kohl Bros.	1960	P	860	V	Sb/rb
186	4051-7518	do.	do.	1960	P	870	V	Sb/rb
188	4058-7507	Arthur Baker	Al Emele, Jr.	1950	H	340	T	Qg/sdgv
189	4058-7508	Delaware Water Gap Bor.	Harrisburg's Kohl Bros.	1961	P	530	S	Sb/rb
190	4112-7523	U. S. Geological Survey	Robert Wayne Knight	1967	U	1960	S	Dcpg/ss
191	4102-7503	National Park Service	Allen J. Greening	1968	R	785	S	Des/sh
199	4057-7507	National Park Service, Mt. Minsi Rec.	do.	1970	R	1430	H	Ss/cg
200	4104-7519	Pa. State Police Barricks	Raymond E. Kresge	1971	H	1170	S	Dclr/ss
201	4104-7519	L. H. Hymes	Howell	1948	H	1175	V	Dclr/ss
202	4104-7500	National Park Service, Wallpack Rec.	D. F. Well Drilling Co.	1971	R	500	V	Dsc/st
203	4113-7529	James Morsey	Robert Wayne Knight	1966	H	1860	H	Dcpg/st
204	4054-7528	R. H. Burger	---	---	H	720	V	Dmh/sh
205	4102-7509	Paul Berner	Kohl Bros., Inc.	1962	H	---	S	Dmh/st
206	4059-7508	Ronson Corp.	R. H. Odenheiner Co.	1963	N	---	V	Spi/ls
207	4105-7519	National Drug Co.	do.	1962	N	---	S	Dclr/ss

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al th ow d s ace (t)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
	Oepth (feet)	Oiameter (inches)		Oepth below land surface (feet)	Oate measured (mo/yr)						
INTY											
92	---	6	---	33	9/48	---	---	---	---	---	Mo- 1
62	---	6	---	18	9/48	---	---	---	---	---	2
52	---	6	---	---	---	---	---	---	---	---	3
0	70	8	---	65	---	60	---	1	35	---	4
37	65	8	---	52	---	---	---	1	65	---	5
50	80	12	---	80	---	85	---	4	149	---	6
0	80	6	---	80	---	---	---	---	---	---	9
79	52	6	---	F	---	---	1.09	---	---	---	13
53	50	---	---	F	---	7	---	---	---	---	15
35	60	8	---	35	---	105	4.77	---	---	---	17
78	---	---	---	---	---	125	---	---	---	---	18
84	84	6	---	F	---	10	---	---	---	---	23
65	165	---	---	---	---	---	---	---	---	---	27
80	80	---	---	68	8/30	8	---	---	---	---	28
75	---	6	---	4	7/30	---	---	---	---	---	35
76	30	5	---	2	---	60	---	---	---	---	44
85	30	4	---	F	---	3	---	---	---	---	45
75	80	8	---	70	---	145	3.77	2	83	---	46
98	31	6	---	20	---	15	1.07	---	---	---	48
80	140	8	---	F	---	30	---	6	---	---	49
26	100	---	---	2	---	---	1	---	---	---	63
80	150	---	---	---	---	---	---	---	---	---	64
86	84	6	---	6	---	8	---	---	---	---	67
10	70	6	---	12	---	20	---	2	---	---	70
61	60	10	---	20	---	170	1	---	---	---	72
27	20	10	---	F	---	225	1.17	---	---	---	73
87	31	8	---	10	---	90	3.33	---	---	---	74
50	300	8	---	100	---	150	---	---	---	---	80
80	27	6	167	7	---	15	0.75	---	---	---	90
87	35	6	---	18	---	20	---	---	---	---	107
70	6	6	---	F	9/12	7	---	---	---	---	113
08	20	6	---	175	---	40	---	---	---	---	122
55	55	6	---	F	---	2	---	---	---	---	127
50	172	6	---	9	---	---	---	---	---	---	141
27	125	6	---	15	---	---	---	---	---	---	153
45	145	---	---	80	---	---	---	---	---	---	154
60	14	---	---	3	---	---	---	1	120	7.6	155
68	30	4	---	---	---	20	---	2	120	7.4	158
73	91	6	---	22	---	28	.18	3	180	7.3	159
50	93	6	---	30	---	---	---	---	---	---	160
65	132	6	---	50	---	---	---	---	160	7.6	161
140	35	6	---	---	---	---	---	---	180	7.7	162
36	1	---	---	6	---	---	---	---	160	7.8	163
103	83	6	---	---	---	---	---	---	---	---	165
124	70	6	---	F	---	---	---	7	320	7.8	166
136	80	6	---	F	---	---	---	---	220	7.7	167
90	86	6	---	5	---	---	---	5	220	8.3	168
145	128	6	---	---	---	---	---	---	---	---	169
98	97	6	---	25	---	15	---	---	325	7.6	170
60	18	6	---	18	---	---	---	19	750	7.7	171
102	8	6	---	7	---	---	---	8	400	7.7	172
222	65	6	---	---	---	---	---	8	390	8.0	173
84	---	6	---	---	---	---	---	8	350	8	174
260	60	6	---	---	---	---	---	---	---	---	175
95	50	6	---	12	---	20	---	9	390	8.0	176
120	20	6	---	---	---	---	---	2	110	8.2	181
171	150	6	---	2	---	---	---	2	120	8.2	182
445	102	10	---	F	---	300	1.3	---	---	---	185
450	102	10	---	F	---	300	1.27	---	---	---	186
143	143	6	---	40	---	2	---	2	75	---	188
300	47	8	---	25	---	450	5.3	---	---	---	189
98	59	6	70;76;80	14	10/67	5	.09	3	50	---	190
308	34	6	108;125;128;160; 238	94	11/68	73	6.3	4	175	6.9	191
300	73	6	104;137;285	212	10/70	2	---	1	65	7.9	199
175	49	8	161	8	2/71	70	0.74	3	140	6.5	200
65	22	6	---	6	2/71	30	---	---	---	---	201
147	---	6	---	7	5/71	75	1.84	6	180	---	202
105	48	6	---	---	8/66	25	---	---	---	---	203
82	---	6	---	---	---	7	---	1	57	---	204
150	20	6	92;123;144	26	10/62	8	.2	---	---	---	205
435	164	8	430	8	6/63	400	3.43	---	---	---	206
260	86	6	90;230;258	13	11/62	100	---	---	---	---	207

TABLE

Well location						Altitude of land surface (feet)	Topographic setting	Aquif litho
Number	Lat-Long	Owner	Driller	Date completed	Use			
Mo- 208	4105-7519	National Drug Co.	R. H. Odenheiner Co.	1962	N	---	H	Dclr/
209	4105-7519	Morgan Batchlor	Kohl Bros., Inc.	1962	H	---	S	Dclr/
210	4112-7514	Donald Wapnick	Charles D. Moyer	1971	H	---	H	Dclr/
211	4100-7506	Manwalamink, Inc.	William Flick	1920	P	300	V	Qg/sd
212	4103-7530	Pocono International Raceway	Mel Fehr & Gil. Overpeck	1968	P	1880	H	Dcpg/
213	4103-7530	do.	Ralph E. Myers	1968	P	1870	H	Dcpg/s
214	4103-7530	do.	Charles D. Moyer	1971	P	1870	H	Qg/ss
215	4103-7509	Robert Galvetz	Jesse L. Dogan	1974	H	1000	H	Dclr/s
216	4107-7517	Wm. Rosenkrantz	do.	---	H	800	H	Dclr/s
217	4107-7521	Pocono Diner	Hawk Drilling	1968	C	1820	H	Dclr/s
218	4050-7522	Aquashicola Est.	Harrisburg's Kohl Bros.	1969	P	---	S	Sb/rb
219	4113-7512	Ralph James	Fehr's Well Drilling	1968	H	1380	V	Dclr/s
220	4111-7514	Joseph Scianone	Hawk Drilling	1968	H	1170	S	Dclr/s
221	4111-7512	Arthur Loufice	do.	1967	H	1350	S	Dclr/s
222	4111-7512	Charles Kimmel	Leon A. Frailey	1971	H	---	S	Dclr/s
223	4058-7522	Fred Javell	Clair T. Miller	1969	H	1060	S	Dclr/s
224	4059-7524	Claude Posenger	do.	1968	H	1020	V	Dclr/s
225	4056-7517	County Home	Hawk Drilling	1975	P	503	V	DSu/ls
226	4056-7516	Jodi Enterprises 2	Jesse L. Dogan	1975	H	865	H	Dhg/ls
227	4142-7518	Mr. Zito	do.	1975	H	990	S	Dclr/s
228	4115-7514	Skytop Lodge Inc.	do.	1929	P	1550	H	Dclr/s
229	4103-7520	Scotrun Water Co.	---	1963	P	1150	H	Dclr/s
230	4110-7521	Pocono Farms Inc.	W. V. Nixon	1965	P	2065	H	Dcpg/s
231	4112-7515	Buck Hill Water Co.	Sprague & Henwood, Inc.	1957	P	1110	S	Dclr/s
232	4109-7516	Weiler Brush Co.	Henry Yeska & Son, Inc.	---	N	1205	V	Dclr/s
233	4054-7521	Hamilton Water Co.	Hawk Drilling	1957	P	935	V	Dtr/st
234	4105-7525	Emerald Lakes	Moody Drilling Co., Inc.	1971	U	1960	S	Dcpg/s
235	4111-7521	Pocono Country Place 1	do.	1973	P	2010	S	Dcpg/s
236	4111-7522	Pocono Country Place 2	do.	1973	P	1985	V	Dcpg/s
237	4113-7522	Pocono Country Place 3	do.	1974	P	2105	V	Dcpg/s
238	4106-7527	Arthur Knecht	Charles D. Moyer	1974	C	1793	S	Dcpg/s
239	4105-7535	First Eastern Bank	---	1975	H	1680	H	Dcd/ss
240	4104-7516	Pocono Union Church	Jesse L. Dogan	1975	H	1100	S	Dclr/s
241	4104-7506	Pocono Highlands Camp	do.	1975	H	750	V	Dmh/sh
242	4101-7504	U.S. Army Corps Engineers	---	---	U	420	T	Spi/ls
243	4059-7510	East Stroudsburg Bor.	Moody Drilling Co., Inc.	1971	P	540	S	Dbf/ls
244	4059-7510	do.	do.	1971	P	520	S	Dbf/ls
245	4100-7520	Stony Hollow 2	Jesse L. Dogan	1975	H	980	S	Dclr/s
246	4058-7509	Delaware Water Gap Bor.	Moody Drilling Co., Inc.	1971	P	370	T	Spi/ls
247	4058-7528	William Bonham	Ralph N. Neeb	1967	H	1160	S	Dclr/s
248	4056-7526	St. John Church	Anthony P. Tomsic	1967	H	820	V	Dcw/ss
249	4056-7526	West End Ambulance	Ralph N. Neeb	1968	H	---	V	Dmh/sh
250	4054-7526	Lloyd Arnold	Charles D. Moyer	1967	H	---	V	Dm/sh
251	4058-7528	Richard Fillis	do.	1968	H	---	S	Dclr/s
252	4057-7531	Henry McManus	do.	1966	H	1220	S	Dclr/s
253	4056-7531	Camp Harlan	Clair L. Kibler	1968	H	990	S	Dclr/s
254	4054-7531	C. H. George	Andrew S. Mermon	1968	H	1010	S	Dtr/sh
255	4103-7527	Long Pond Residents, C-8	Charles D. Moyer	---	H	1885	U	Dcpg/s
256	4104-7526	G. Cohen	Andrew S. Mermon	1968	H	1905	U	Dcpg/s
257	4103-7529	Hoffman	William Becker	1966	H	1870	S	Dcpg/s
258	4105-7532	Emlem Woodruff	Ralph E. Myers	1967	H	1660	S	Dcpg/s
259	4104-7534	Doris Asarowicz	Charles D. Moyer	1971	H	1620	S	Dcpg/s
260	4104-7530	Harvey Smith	Fehr's Well Drilling	1967	H	1840	S	Dcpg/s
261	4103-7513	Neil Summers	Charles D. Moyer	1967	H	660	S	Dcw/ss
262	4104-7507	John Yarish	Barry Frailey	1971	H	1020	H	Dtr/st
263	4057-7520	Brt.'s Grn. Acres Develop.	---	---	H	780	S	Dmh/sh
264	4059-7521	Gruber Lake Develop.	---	---	H	1000	S	Dclr/s
265	4052-7524	Joe Decker	Raymond E. Werner	1968	H	850	S	Dmh/sh
266	4051-7519	Roger Green	do.	1969	H	790	S	Sb/rb
267	4059-7513	Donald Lee	Charles D. Moyer	1967	H	765	S	Dmh/sh
268	4058-7511	Murry Abeloff	Clair T. Miller	1971	H	720	S	Des/st
269	4053-7523	Waren Johnson	Anthony P. Tomsic	1972	H	900	V	Dcw/ss
270	4054-7528	Marvin Ritter	Charles D. Moyer	1967	H	695	V	Dm/sh
271	4050-7526	Rothe Ara	do.	1966	H	550	S	Sb/rb
272	4050-7527	Kunkletown Residents	---	---	H	550	S	Dmh/sh
273	4051-7528	Kingswood Estates Develop.	---	---	H	640	S	Dcw/ss
274	4054-7516	Cherry Valley Hatchery	Richard Rumsey	1971	Z	520	V	Qg/sdg
275	4058-7515	Royal Rock Sadd	Clair T. Miller	1968	P	510	U	Dm/sh
276	4055-7517	Bernard Fisher	Richard Rumsey	1971	H	645	H	DSu/sh

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otal epth elow and rface eet)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
400	40	8	105;245;272;382	100	2/62	150	2	---	---	---	Mo- 208
200	35	6	162	42	10/62	7	.04	---	---	---	209
265	80	6	186;261	62	6/71	12	.06	---	---	---	210
26	26	48	---	---	---	200	13.3	2	---	6.4	211
212	58	6	90	60	9/68	51	5.0	---	---	---	212
150	75	6	---	---	---	22	---	---	---	---	213
290	32	8	---	33	---	250	1.7	---	---	---	214
170	86	6	109;138	14	9/74	10	.09	---	---	---	215
223	160	6	164;200	10	9/74	15	.06	---	---	---	216
147	102	6	115;130;140	60	---	50	.57	---	---	---	217
250	50	8	80;160	30	9/69	264	2.26	3	---	---	218
160	104	6	---	50	4/68	12	1.2	---	---	---	219
198	43	6	---	20	1/68	8	.04	---	---	---	220
272	26	5	---	100	5/67	5	.02	---	---	---	221
100	23	6	---	39	6/71	8	.14	---	---	---	222
100	25	6	---	50	---	35	1.75	---	---	---	223
115	20	6	---	55	5/68	15	.25	---	---	---	224
524	118	6	120;420	4	5/75	---	---	---	425	---	225
421	70	6	195;330;388	250	9/75	15	---	---	---	---	226
655	23	6	---	126	9/75	2	0.29	---	375	---	227
500	---	6	---	60	---	50	1.5	3	---	---	228
166	117	6	---	28	---	43	---	2	---	7.2	229
301	22	6	85;203;260;286	70	1965	40	13.3	2	---	7.0	230
300	45	10	---	58	1957	133	---	2	---	7.0	231
465	47	6	197;288;428;449	---	---	75	---	---	---	---	232
360	14	6	---	F	---	15	---	---	---	---	233
697	61	8	267;428;579	102	8/71	40	0.26	5	200	7.8	234
616	83	8	75;586	15	8/73	70	2.08	3	92	7.25	235
346	99	8	---	6	8/73	400	10.7	4	90	6.9	236
568	67	8	4;341;488	6	2/74	100	1.38	---	60	---	237
575	68	6	---	4	9/75	20	0.36	---	130	---	238
170	45	6	---	40	9/75	20	---	---	---	---	239
224	34	6	85;210	26	5/75	20	---	---	700	---	240
052	38	6	140;270;515;630; 890	15	6/75	12	---	---	200	---	241
420	29	6	70;250;380	33	11/74	---	---	---	200	---	242
720	39	8	---	91	1/71	200	3.13	10	450	7.5	243
705	41	8	134;309;458	69	2/71	100	1.5	12	475	7.7	244
324	33	6	70;194;294	32	9/75	3	---	---	---	---	245
623	201	8	207;306;552	38	4/71	450	4.17	14	---	8.0	246
122	24	6	---	60	6/67	30	3	---	---	---	247
140	42	6	---	8	---	50	.38	---	---	---	248
72	57	6	---	10	1/68	40	4	---	---	---	249
156	115	6	---	18	10/67	20	---	---	---	---	250
106	24	6	---	50	6/68	30	1	---	---	---	251
202	180	6	---	90	12/66	20	---	---	---	---	252
130	18	6	---	100	5/68	45	---	---	---	---	253
180	113	6	---	180	10/68	6	.08	---	---	---	254
147	48	6	---	33	---	28	0.43	---	---	---	255
170	94	6	---	75	6/68	18	.72	---	---	---	256
---	---	6	---	15	---	40	8	---	---	---	257
139	21	6	---	8	3/67	50	12.5	---	---	---	258
175	102	---	---	55	3/71	30	---	---	---	---	259
70	35	6	---	7	12/67	70	1.63	---	---	---	260
232	105	6	---	60	6/67	10	.09	---	---	---	261
271	21	6	---	100	8/71	4	.02	---	---	---	262
125	56	6	---	40	---	15	0.24	---	---	---	263
90	31	6	---	30	---	20	0.41	---	---	---	264
355	85	6	---	45	12/68	17	.06	---	---	---	265
150	103	6	---	53	2/69	30	.52	---	---	---	266
240	61	6	---	190	6/67	12	.4	---	---	---	267
200	20	6	---	105	3/71	8	.14	---	---	---	268
535	15	6	---	85	9/72	7	.016	---	---	---	269
358	81	6	---	110	8/67	12	.06	---	---	---	270
233	151	6	---	60	8/66	20	.08	---	---	---	271
101	22	6	---	35	---	20	2.00	---	---	---	272
122	33	6	---	32	---	18	0.18	---	---	---	273
64	64	6	---	9	5/71	30	2.14	---	---	---	274
100	20	6	---	25	2/68	35	1.4	---	---	---	275
175	175	6	---	F	11/71	8	.05	---	---	---	276

TABLE

Well location		Owner	Driller	Date completed	Use	Altitude of land surface (feet)	Topographic setting	Aquif lithogy
Number	Lat-Long							
Mo- 277	4053-7519	Frank Gennusa	Clair T. Miller	1971	H	660	S	Dm/sh
278	4054-7518	Donald Smith	do.	1969	H	760	S	Dbf/w
279	4104-7503	Echo Lot 2, Echo Lake	Fehr's Well Drilling	1968	H	525	V	Qg/sd
280	4055-7516	Thomas Andre	Anthony P. Tomsic	1972	H	685	T	Qg/sd
281	4109-7511	R. Missirian	Charles D. Moyer	1969	H	1280	H	Dclr/
282	4109-7512	Jodie Davenport	Barry Frailey	1971	H	1000	U	Dclr/
283	4109-7512	Lou Martinell	Clair T. Miller	1967	H	1005	S	Dclr/
284	4106-7512	Kenneth Long	do.	1970	H	1055	U	Dclr/
285	4106-7514	Nicholls	Hawk Drilling	1968	H	1065	H	Dclr/
286	4106-7515	Schaffner	do.	1968	H	890	S	Dclr/
287	4105-7516	John Plater	Clair T. Miller	---	H	880	V	Dclr/
288	4105-7516	Nelson Smith	do.	1968	H	920	U	Dclr/
289	4105-7517	Elwood Wrolston	do.	1967	H	920	U	Dclr/
290	4104-7516	Richard Bais	Fehr's Well Drilling	1968	H	1190	S	Dclr/
291	4105-7521	M. Tamburri	Clair T. Miller	1970	H	1720	H	Dcp/ss
292	4108-7517	Nelson Smith	do.	1969	H	1220	H	Dclr/s
293	4107-7520	C. O. Thoms	Hawk Drilling	1967	H	1720	S	Dclr/s
294	4108-7532	Dwyer	Charles D. Moyer	1971	H	1810	H	Dcd/ss
295	4108-7532	Langdon	Champion Drilling	1968	H	1770	U	Dcd/ss
296	4108-7532	Stephen Damich	William Becker	1966	H	1795	U	Dcd/ss
297	4104-7519	Peter Nish	Jesse L. Dogan	---	H	1200	H	Dclr/s
298	4058-7523	Arthur Boder	Leon A. Frailey	1972	H	990	S	Dcw/ss
299	4059-7521	William Klauson	do.	1971	H	990	S	Dcbr/s
300	4058-7517	Carl Shafer	Clair T. Miller	1968	H	800	S	Dmh/sh
301	4054-7518	George Schimff	do.	1971	H	720	H	Dm/ss
302	4055-7520	Eugene Arr	do.	1971	H	800	S	Dm/sh
303	4058-7518	John Reaser	Leon A. Frailey	1969	H	720	S	Dmh/sh
304	4059-7521	Harry Kollner	Clair T. Miller	1968	H	940	S	Dcw/sh
305	4047-7514	James Marsh	Jesse L. Dogan	1976	H	660	H	Dbf/ls
306	4502-7513	Richard Barry	Leon A. Frailey	1969	H	510	V	Dct/ss
307	4100-7515	Dewey Meckes	Andrew S. Mermon	1966	H	830	S	Dct/ss
308	4055-7529	Harvey Berger	Charles D. Moyer	1968	H	770	V	Dct/ss
309	4103-7510	William Burwell	Duane M. Fehr	1968	H	---	V	Dtr/wr
310	4100-7519	Glen Barton	do.	1967	H	890	S	Dcw/sh
311	4101-7516	Russell Newsome	Leon A. Frailey	1966	H	890	S	Dcw/wr
312	4101-7521	Lawrence Knoefl	do.	1968	H	1090	S	Dclr/s
313	4101-7519	Morris Randall	do.	1968	H	1000	S	Dclr/s
314	4103-7516	William Evans	Fehr's Well Drilling	1968	H	1090	S	Dclr/s
315	4106-7517	Leonard Grabco	Clair T. Miller	1971	H	970	S	Dclr/s
316	4113-7530	Pocono Forest Develop., C-6	Robert Wayne Knight	1974	H	1795	S	Dcd/ss
317	4057-7514	William Hopkins	Jesse L. Dogan	1975	H	665	H	Dbf/ls
318	4105-7525	Emerald Lake Develop., C-24	---	---	H	2000	U	Dcpg/s
319	4104-7523	Crescent Lake Develop., C-7	---	---	H	1775	S	Dclr/s
320	4106-7527	Lake Naomi Develop., C-145	---	---	H	1780	S	Dcpg/s
321	4107-7524	Stillwater Lake Develop., C-14	---	---	H	1825	U	Dcpg/s
322	4100-7530	Indian Mtn. Lake Develop., C-71	---	---	H	1810	S	Dcpg/s
323	4108-7532	Locust Lake Develop., C-225	---	1970	H	1755	U	Dcd/ss
324	4108-7534	Arrow Head Lake Develop., C-94	---	---	H	1680	U	Dcd/ss
325	4058-7531	Robin Hood Lakes Develop., C-14	---	---	H	1260	S	Dclr/ss
326	4057-7530	Pleasant Valley Develop., C-27	---	---	H	1100	S	Dclr/ss
327	4103-7519	Residents of Scot Run, Pa., C-13	---	---	H	1055	S	Dclr/ss
328	4102-7518	Residents of Tannersville, C-20	---	---	H	900	S	Dclr/ss
329	4504-7508	Pocono Heights Develop., C-15	---	---	H	1080	S	Dtr/ss
330	4107-7508	Lake Monroe Develop., C-9	---	---	H	1030	S	Dclr/ss
331	4105-7511	Residents of Wooddale, C-5	---	---	H	1040	S	Dcw/ss
332	4102-7508	Residents of Marshall Crk., C-5	---	---	H	500	V	Dm/sh
333	4106-7530	Residents Forest Glenn, C-5	---	---	H	1685	S	Dcd/ss
334	4104-7503	Echo Lake Develop., C-5	---	---	H	530	V	Dm/sh
335	4104-7506	Residents of Poplar Bridge, C-8	---	---	H	800	V	Dmh/sh
336	4101-7511	James Halterman	Barry Frailey	1972	H	470	V	Qg/sdgv
337	4101-7509	Clifford Safen	Leon A. Frailey	1966	H	540	S	DSu/ls

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Casing Depth (feet)	Casing Diameter (inches)	Depth(s) to water-bearing zone(s) (feet)	Static water level Depth below land surface (feet)	Static water level Date measured (mo/yr)	Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
120	6	---	50	11/71	35	3.5	---	---	---	Mo- 277
250	6	---	70	9/69	35	3.5	---	---	---	278
62	6	---	10	1968	52	5.2	---	---	---	279
125	6	---	50	10/72	30	3.00	---	---	---	280
33	6	---	46	10/69	2	.008	---	---	---	281
21	6	---	200	7/71	1	.007	---	---	---	282
148	6	---	105	10/67	12	.15	---	---	---	283
71	6	---	18	7/70	8	.09	---	---	---	284
95	6	---	50	5/68	8	.05	---	---	---	285
145	6	---	30	4/68	100	.5	---	---	---	286
25	6	---	160	---	10	.7	---	---	---	287
80	6	---	30	8/68	6	.1	---	---	---	288
98	6	---	25	8/67	14	.35	---	---	---	289
22	6	---	100	10/68	5	.05	---	---	---	290
225	6	---	100	12/70	11	.11	---	---	---	291
80	6	---	110	11/69	15	.3	---	---	---	292
20	6	---	200	12/67	6	.02	---	---	---	293
23	6	---	320	7/71	7	.03	---	---	---	294
50	6	---	102	1/68	5	.04	---	---	---	295
22	6	---	25	7/66	30	1	---	---	---	296
22	6	35;162;190;290	125	9/74	60	.34	---	---	---	297
60	6	---	100	9/72	15	.3	---	---	---	298
43	6	---	40	11/71	15	.17	---	---	---	299
28	6	---	18	7/68	11	.13	---	---	---	300
---	---	---	105	6/71	13	.86	---	---	---	301
30	6	---	80	11/71	20	.28	---	---	---	302
21	6	---	22	9/69	10	.06	---	---	---	303
45	6	---	75	10/68	15	.25	---	---	---	304
33	6	240	180	7/76	1.5	.025	---	---	---	305
21	6	---	18	8/69	10	0.33	---	---	---	306
85	6	---	5	8/66	12	0.10	---	---	---	307
---	6	---	60	6/68	12	0.12	---	---	---	308
17	6	---	7	9/68	11	1.6	---	---	---	309
43	6	---	20	10/67	10	0.11	---	---	---	310
21	6	---	50	7/66	20	0.29	---	---	---	311
20	6	---	3	11/68	15	.22	---	---	---	312
21	6	---	32	10/68	13	.12	---	---	---	313
21	6	---	22	5/68	14	.18	---	---	---	314
100	6	---	15	9/71	15	.37	---	---	---	315
55	6	---	25	---	16	0.16	---	---	---	316
59	6	---	70	4/75	20	.2	---	---	---	317
102	6	---	62	---	22	0.31	---	---	---	318
125	6	---	70	---	20	0.22	---	---	---	319
41	6	---	20	---	20	0.27	---	---	---	320
41	6	---	10	---	30	0.49	---	---	---	321
52	6	---	28	---	20	0.37	---	---	---	322
40	6	---	42	1970	12	0.17	---	---	---	323
40	6	---	30	---	10	0.16	---	---	---	324
24	6	---	47	---	30	1.60	---	---	---	325
43	6	---	65	---	15	0.20	---	---	---	326
21	6	---	50	---	13	0.30	---	---	---	327
21	---	---	25	---	14	0.18	---	---	---	328
23	6	---	30	---	5	0.08	---	---	---	329
27	6	---	28	---	8	0.50	---	---	---	330
22	6	---	50	---	11	0.15	---	---	---	331
32	6	---	20	---	30	1.00	---	---	---	332
30	6	---	25	---	15	0.17	---	---	---	333
64	---	---	20	---	18	0.36	---	---	---	334
21	6	---	20	---	8	0.06	---	---	---	335
49	6	---	5	7/72	20	0.45	---	---	---	336
21	6	35;55;122	15	5/66	30	0.46	---	---	---	337

TABLE 1

Well location								
Number	Lat-Long	Owner	Driller	Date completed	Use	Altitude of land surface (feet)	Topographic setting	Aquifer lithol
Mo- 338	4100-7512	Aaron Smith	Duane M. Fehr	1967	H	590	V	Dm/sh
339	4102-7512	Peter Gerard	Leon A. Frailey	1969	H	505	V	Dtr/st
340	4100-7513	Carmen Coco	Harlan and Fenical	1967	H	790	H	Dmh/sh
341	4103-7514	Lloyd Metzgar	Fehr's Well Drilling	1968	H	775	S	Dcw/ss
342	4103-7514	Bruce Wismer	Clair T. Miller	1969	H	---	S	Dcbr/ss
343	4101-7511	Adrian Walker	Duane M. Fehr	1967	H	555	V	DSu/sh
344	4102-7510	Renn Contr.	Charles D. Moyer	1970	H	500	V	Dm/sh
345	4058-7513	Berne Warner	Clair T. Miller	1971	H	490	V	Dm/sh
346	4057-7513	Kostenbader	do.	1970	H	405	V	Dco/ls
347	4056-7513	Warner Farnell	Anthony P. Tomsic	1975	H	685	S	Sb/rb
348	4051-7520	Harold Maeir	Henry H. Bruch	1968	H	740	S	Sb/rb
349	4100-7517	Barton Glen Develop., C-13	---	---	H	950	S	Dtr/st
350	4100-7517	Vaccaro	Jesse L. Dogan	1976	H	960	S	Dct/sh
351	4051-7521	Raymond Wooley	Fehr's Well Drilling	1968	H	620	V	Spi/sh
352	4051-7521	Jacob Hoagland	Henry H. Bruch	1968	H	650	S	Spi/sh
353	4051-7521	Carl Muntz	do.	1968	H	625	S	Sb/rb
354	4058-7510	House of Ming	Mel Fehr & Gil. Overpeck	1972	H	710	H	Des/sh
355	4059-7516	Holiday Inn	Hawk Drilling	1974	P	770	H	Dmh/sh
356	4059-7516	do.	do.	---	P	770	H	Dmh/sh
357	4059-7516	do.	do.	---	P	770	H	Dmh/sh
358	4050-7526	Carl Reicke	Charles D. Moyer	1968	H	720	H	DSu/ss
359	4050-7528	Phillip Marano	Kermit K. Borger	1975	H	775	S	Dtr/ls
360	4050-7528	Anthony Wissler	do.	---	H	730	S	Dmh/st
361	4051-7527	Harry Krechel	Clair L. Kibler	1973	H	945	H	Dtr/st
362	4052-7527	G. F. Hawk	Andrew S. Mermon	1968	H	900	H	Dclr/ss
363	4053-7527	do.	do.	1966	H	990	H	Dcw/ss
364	4103-7511	Joseph Santim	Jesse L. Dogan	1975	H	950	S	Dct/st
365	4100-7509	Wm. Gordon	Ralph E. Myers	---	H	---	S	DSu/--
366	4102-7510	E. R. Shaw	Jesse L. Dogan	1975	H	750	S	Dmh/st
367	4112-7513	Arnold Conn	do.	1976	H	1370	H	Dclr/ss
368	4114-7516	Lake in the Clouds Develop., C-5	---	---	H	1900	S	Dcpg/ss
369	4106-7508	Ball	Jesse L. Dogan	1976	H	960	S	Dclr/ss
370	4106-7507	Frizziola	do.	---	H	1000	V	Dclr/ss
371	4106-7503	J. F. Lee	do.	1975	H	970	H	Dtr/st
372	4053-7523	Hilltop Acres Develop., C-18	---	1975	H	970	S	Dcw/ss
373	4054-7523	Beechwood Acres Develop., C-8	---	1975	H	1100	H	Dct/ss
374	4106-7508	Wilderness Acres Develop., C-5	---	1975	H	1000	S	Dclr/ss
375	4103-7509	Ramond Freeman	Jesse L. Dogan	1976	H	940	S	Dmh/st
376	4108-7518	Anrei Dulak	do.	1975	H	1200	S	Dclr/ss
377	4106-7516	Lord Properties	do.	1975	H	---	S	Dclr/ss
378	4105-7514	Richard Kennedy	do.	1975	H	760	S	Dclr/ss
379	4106-7518	David McCabe	do.	1976	H	1130	S	Dclr/ss
380	4105-7518	S. H. Hackenberg	do.	1976	H	---	S	Dclr/ss
381	4105-7518	Callen	do.	1976	H	1040	S	Dclr/sh
382	4103-7514	Thomas Vandecker	do.	1976	H	---	S	Dclr/sh
383	4102-7516	R. B. Vandecker	do.	1976	H	980	H	Dclr/sh
384	4105-7516	Anton Bonifacic	do.	1976	H	1090	S	Dclr/sh
385	4109-7512	Carole Garmola	do.	1976	N	1115	S	Dclr/ss
386	4109-7512	William Marin	do.	1976	H	1210	H	Dclr/ss
387	4059-7515	John Werner	do.	1975	H	770	S	Dmh/sh
388	4101-7515	Rose Bosher	do.	1976	H	860	S	Dct/sh
389	4102-7508	Russel Scott	Ralph E. Myers	1973	H	---	S	Dmh/sh
390	4058-7514	Wiesmeth Constr.	Jesse L. Dogan	1976	H	570	S	Dm/sh
391	4105-7535	Sportsman Motel	Robert J. Shelhamer	---	C	1670	H	Dcd/ss
392	4106-7525	Poyer	Jesse L. Dogan	1975	H	1860	S	Dcpg/ss
393	4105-7527	George Romoser	do.	1976	H	1820	S	Dcpg/ss
394	4106-7526	William Cramer	do.	1976	H	1780	S	Dcpg/ss
395	4105-7534	Camelot Forest Develop., C-23	---	1973	H	1660	S	Dcd/ss
396	4054-7526	Residents of Gilbert, Pa., C-17	---	1967	H	710	V	Dm/sh
397	4055-7523	Residents of Brodheadsville, Pa.	---	---	H	745	V	Dm/sh
398	4059-7527	Sun Valley Develop., C-29	---	1971	H	1240	S	Dclr/ss
399	4056-7526	Robert Altemose	Leon A. Frailey	1972	H	785	V	Dtr/ss
400	4057-7523	William Hoffner	Richard Rumsey	1970	H	810	V	Qg/sdgv
401	4057-7523	J. F. Stengor	William D. Krock	1971	H	1000	S	Dtr/ss
402	4056-7523	A. Burke	Richard Rumsey	1970	H	730	S	Dmh/sh
403	4056-7526	D. M. Dailey	Andrew S. Mermon	1967	H	845	V	Dcw/sh
404	4102-7532	Briar Crest Develop., C-7	---	---	H	1890	H	Dcd/ss
405	4058-7522	Sherwood Forest Develop., C-9	---	---	H	1100	S	Dcw/ss
406	4104-7516	Alpine Lake Develop., C-15	---	---	H	1160	S	Dclr/ss

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al th ow d ace t)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
5	23	6	110	19	8/67	10	0.10	---	---	---	Mo- 338
0	21	6	50;80;135	36	7/69	10	0.09	---	---	---	339
2	15	6	32;50	20	9/67	30	3.00	---	---	---	340
9	22	6	60;93;125	25	10/68	8	0.08	---	---	---	341
3	29	6	45;95	28	4/69	38	1.19	---	---	---	342
0	23	6	64;105;125	15	9/67	10	0.09	---	---	---	343
0	---	6	187;206	48	5/70	18	0.18	---	---	---	344
5	86	6	125;180	40	11/71	35	0.50	---	---	---	345
5	59	6	72;110	10	5/70	35	0.44	---	---	---	346
0	21	6	70;130	30	9/75	10	0.10	---	---	---	347
4	64	6	---	43	6/68	80	13.3	---	---	---	348
2	36	6	---	60	---	12	0.12	---	---	---	349
2	42	6	125;138;280	120	6/76	4	0.03	---	---	---	350
0	52	6	55;60;67	8	6/68	20	0.32	---	---	---	351
0	35	6	---	18	---	20	20.0	---	---	---	352
5	57	6	---	45	8/68	23	2.88	---	---	---	353
0	125	6	---	40	8/72	3	.006	---	---	---	354
0	20	6	---	30	8/74	76	---	---	---	---	355
0	20	6	---	---	---	60	---	---	---	---	356
0	20	6	---	---	---	12	---	---	---	---	357
5	---	---	---	54	4/68	30	---	---	---	---	358
5	43	6	---	56	11/75	12	0.3	---	---	---	359
5	21	6	---	---	---	10	---	---	---	---	360
5	33	6	---	90	12/73	25	1.25	---	---	---	361
3	33	6	---	90	1/68	10	.35	---	---	---	362
5	37	6	---	80	11/66	7	.13	---	---	---	363
7	34	6	45;65;130	12	---	10	.09	---	---	---	364
0	21	6	---	---	---	10	.07	---	---	---	365
7	35	6	---	20	---	20	.2	---	---	---	366
3	50	6	---	27	5/76	7	.04	---	---	---	367
1	24	6	---	33	---	10	.30	---	---	---	368
7	52	6	---	60	2/76	3	.03	---	---	---	369
2	25	6	---	20	---	5	.07	---	---	---	370
2	33	6	---	120	4/75	12	.08	---	---	---	371
5	44	6	---	90	1975	11	0.24	---	---	---	372
5	37	6	---	70	1975	5	0.04	---	---	---	373
3	34	6	---	73	---	4	0.04	---	---	---	374
2	38	6	---	30	6/76	10	.06	---	---	---	375
7	80	6	---	55	6/75	15	00.3	---	---	---	376
7	40	6	---	56	8/75	3	0.02	---	---	---	377
7	114	6	---	98	10/75	20	00.3	---	---	---	378
3	99	6	122;168	40	---	10	0.07	---	---	---	379
7	42	6	---	85	5/76	5	.04	---	---	---	380
7	34	6	---	50	5/76	10	0.33	---	---	---	381
7	29	6	85;127	30	6/76	10	0.1	---	---	---	382
2	42	6	---	45	6/76	30	.66	---	---	---	383
3	30	6	---	5	6/76	10	.14	---	---	---	384
3	21	6	---	170	5/76	20	.28	---	---	---	385
0	22	6	---	150	5/76	30	.17	---	---	---	386
7	40	6	---	27	11/75	3	.02	---	---	---	387
8	36	6	---	15	4/76	7	.06	---	---	---	388
0	21	6	---	75	10/73	20	.05	---	---	---	389
7	42	6	---	30	6/76	5	.07	---	---	---	390
5	37	6	---	20	---	35	.19	---	---	---	391
1	31	6	---	40	3/75	10	.16	---	---	---	392
3	52	6	---	80	4/76	30	.5	---	---	---	393
2	42	6	---	F	6/76	30	.43	---	---	---	394
0	44	6	---	41	8/73	18	0.14	---	---	---	395
0	61	6	---	20	8/67	24	0.86	---	---	---	396
5	123	6	---	23	---	30	0.85	---	---	---	397
5	51	6	---	54	---	20	1.67	---	---	---	398
0	50	6	55;70;90	33	9/72	30	0.81	---	---	---	399
1	70	6	---	46	10/70	30	30	---	---	---	400
0	24	6	85;158	61	4/71	6	0.18	---	---	---	401
0	87	6	88;125;139	15	7/70	18	0.15	---	---	---	402
5	20	6	---	9	8/67	30	1.11	---	---	---	403
0	38	6	---	79	---	15	.16	---	---	---	404
0	50	---	---	50	---	15	0.30	---	---	---	405
6	24	6	---	25	---	10	.14	---	---	---	406

TABLE

Well location		Owner	Driller	Date completed	Use	Altitude of land surface (feet)	Topographic setting	Aquif litho
Number	Lat-Long							
Mo- 407	4105-7504	Lake Winona Develop., C-35	---	1973	H	865	H	Dmh/s
408	4058-7518	Woodhill Develop., C-11	---	1974	H	820	H	Dmh/s
409	4101-7517	Laurel Lake Develop., C-21	---	1975	H	940	S	Dcw/s
410	4057-7517	Donald Rubino	Anthony P. Tomsic	1974	H	580	S	Dmh/l
411	4055-7528	Hemlock Lake Develop., C-6	---	---	H	750	S	Dmh/s
412	4059-7513	Wedgewood Lake Develop., C-16	---	---	H	620	S	Dmh/s
413	4058-7528	Fred Young	Ralph N. Neeb	1968	H	1145	H	Dclr/
414	4056-7518	Sandhill Develop., C-16	---	---	H	650	H	Dm/sh
415	4058-7519	Dewey Meches	Andrew S. Mermon	1966	H	980	S	Dmh/s
416	4108-7531	U.S. Geological Survey	Jesse L. Dogan	1975	U	1783	H	Dcd/s
417	4057-7521	Ernest Nelson	Duane M. Fehr	1968	H	880	S	Dmh/s
418	4111-7521	Pocono Country Place	Jesse L. Dogan	1974	R	2020	S	Dcpg/
419	4055-7520	Meadow Lake Develop., C-9	---	---	H	870	H	Dmh/s
420	4053-7521	Rossland Lake Develop., C-8	---	---	H	850	H	Dmh/s
421	4054-7522	Birchwood Acres Develop., C-6	---	---	H	---	H	Dcw/s
422	4109-7511	Snow Hill Residents, C-11	---	---	H	1220	H	Dclr/
423	4054-7522	Composite well	---	1974	H	1145	H	Dct/s
424	4053-7518	Kenneth Kleintop	Richard Rumsey	1974	H	665	V	Qg/sd
425	4106-7513	Timber Hill Develop., C-12	---	---	H	---	S	Dclr/
426	4105-7535	Blakeslee Area, C-12	---	---	H	1660	S	Dcd/s
427	4053-7517	Paul Bretz	Richard Rumsey	1971	H	640	V	Sb/rb
428	4052-7520	Bradberry and Wilson	Anthony P. Tomsic	1974	H	720	S	Dm/sh
429	4054-7517	Robert Haney	Clair T. Miller	1968	H	600	V	Dmh/l
430	4055-7518	Paul Edigor	do.	1968	H	815	S	Qg/sd
431	4055-7519	Sciota Residents, C-5	---	---	H	565	V	Dm/sh
432	4056-7520	Martin Hansen	Leon A. Frailey	1966	H	680	S	Dm/sh
433	4054-7520	Nicholas Capone	Raymond E. Werner	1970	H	940	S	Dmh/s
434	4054-7520	Ronald Keiper	Anthony P. Tomsic	1975	H	800	S	Dmh/s
435	4059-7516	Thomas Burger	Duane M. Fehr	1968	H	760	S	Dmh/s
436	4108-7521	Ike Miller	Leon A. Frailey	1968	H	1870	H	Dcpg/
437	4052-7530	Philip Lapenta	Andrew S. Mermon	1968	H	900	S	Dct/s
438	4053-7530	Herbert Yost	do.	1969	H	960	S	Dct/s
439	4053-7530	John Stanly	do.	1968	H	835	S	Dmh/s
440	4055-7531	William George	do.	1967	H	855	S	Dclr/
441	4106-7531	R. Laubenstine	Ralph E. Myers	1968	H	1660	H	Dcd/s
442	4106-7536	John Burger	do.	1966	H	1640	L	Dcd/s
443	4107-7533	Earl Christman	do.	1967	H	1740	L	Dclr/
444	4107-7522	Pocono Summit Est. Develop., C-12	---	---	H	1840	S	Dcpg/
445	4056-7522	Scotia Holmes	William D. Krock	1974	H	740	V	Qg/ss
446	4055-7523	George Fritzinger	Charles D. Moyer	1974	H	720	V	Qg/sd
447	4103-7519	Charles Kissling	Fehr's Well Drilling	1967	H	1040	S	Dclr/
448	4054-7516	Frank Domotor	Anthony P. Tomsic	1974	H	480	V	DSu/s
449	4103-7520	Virginia Dennison	Clair J. Miller	1969	H	1080	V	Dclr/
450	4103-7520	G. Riley	Leon A. Frailey	1967	H	1170	S	Qg/sd
451	4109-7522	Joe Galvin	Fehr's Well Drilling	1968	H	1935	S	Dcpg/
452	4057-7520	Kenneth Schuler	William D. Krock	1972	H	770	S	Qg/sd
453	4113-7526	Robert Meckes	Charles D. Moyer	1967	H	1980	S	Dcd/s
454	4110-7523	Residents east of Tobyhanna, C-6	---	1975	H	1970	U	Dcpg/
455	4103-7505	John Wildrick	Anthony P. Tomsic	1975	H	520	V	Dm/sh
456	4059-7513	---	Mel Fehr & Gil. Overpeck	1972	H	720	S	Dm/sh
457	4056-7516	Elwood Williams	Andrew S. Mermon	1968	H	640	S	DSu/s
458	4055-7523	Steve Mehas	Leon A. Frailey	1968	H	760	V	Qg/sd
459	4114-7516	Vaughn Gravel	Clair T. Miller	1970	H	1390	S	Dclr/
460	4113-7516	Harriet Gravel	do.	1969	P	1260	S	Dclr/
461	4108-7524	Bill Rowe	Anthony P. Tomsic	1974	H	1830	S	Qg/sd
462	4110-7517	Mo Nom O Nock Inn	Hawk Drilling	1968	C	1520	H	Dclr/
463	4100-7513	Charles Graybull	Barry Frailey	1976	H	480	V	Dm/sh
464	4101-7510	Carl Seal	Charles D. Moyer	1974	H	480	V	Dm/sh
465	4102-7509	Colonial Holmes	Terry M. Mayer	1973	H	480	V	Dm/sh
466	4113-7530	Mr. Vasvilla	Robert Wayne Knight	1974	H	1750	V	Dcd/s
467	4101-7506	David Longlor	Henry Yeska & Son, Inc.	1972	H	425	S	Dhg/l
468	4101-7506	Nancy Hebard	Jesse L. Dogan	1975	H	400	V	Dhg/l
469	4103-7503	Frank Piper	Ralph E. Myers	1976	H	500	V	Dmh/s

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tal pth low nd face et)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
72	33	6	---	68	---	8	0.06	---	---	---	Mo- 407
8	29	6	---	23	---	10	0.18	---	---	---	408
0	27	6	---	28	---	13	0.12	---	---	---	409
5	52	6	150;250;300;450	50	1/74	18	0.18	---	---	---	410
1	42	6	---	5	---	19	0.68	---	---	---	411
0	25	6	---	20	---	10	0.10	---	---	---	412
4	74	6	---	50	5/68	20	0.67	---	---	---	413
8	22	6	---	35	---	15	0.18	---	---	---	414
4	26	6	35;105	35	8/66	18	0.28	---	---	---	415
4	19	6	99;207;250;534	38	8/75	50	1.16	---	160	---	416
5	80	6	108	---	5/68	35	1.75	---	---	---	417
8	52	6	60;117;135	5	7/74	30	.31	---	---	---	418
0	45	6	---	40	---	9	0.05	---	---	---	419
5	24	6	---	50	---	9	0.19	---	---	---	420
8	23	6	---	68	---	6	0.03	---	---	---	421
0	30	6	---	74	---	10	0.10	---	---	---	422
5	41	6	---	70	8/74	4	0.01	---	---	---	423
0	158	6	---	76	7/74	20	0.71	---	---	---	424
3	22	6	---	50	---	6	.03	---	---	---	425
5	39	6	---	40	---	19	.16	---	---	---	426
5	72	6	72	10	10/71	40	2.00	---	---	---	427
3	118	6	---	50	10/74	9	0.13	---	---	---	428
5	50	6	70;100	4	5/68	15	1.00	---	---	---	429
-	---	---	---	7	3/68	50	2.78	---	---	---	430
5	42	6	---	20	---	20	0.22	---	---	---	431
5	20	6	---	10	7/66	10	0.06	---	---	---	432
	41	6	---	64	9/70	28	0.58	---	---	---	433
	62	6	210;300	80	5/75	3	0.01	---	---	---	434
	22	6	55;145	25	11/68	8	0.06	---	---	---	435
	25	6	---	54	8/68	35	2.18	---	---	---	436
	27	6	80;135	80	6/68	20	0.44	---	---	---	437
	45	6	60;120	60	2/69	15	0.25	---	---	---	438
	64	6	70;95	40	8/68	15	0.27	---	---	---	439
	23	6	30;62	5	4/67	30	0.86	---	---	---	440
	35	6	52;65;100	28	9/68	30	4.29	---	---	---	441
	31	6	44;84;98	15	10/66	40	40.0	---	---	---	442
	61	6	67;92;118	12	9/67	30	0.79	---	---	---	443
	39	6	---	19	---	25	0.42	---	---	---	444
	---	---	---	18	7/74	20	20	---	---	---	445
	111	6	---	28	5/74	30	1.36	---	---	---	446
	241	6	249;252;258	35	9/67	27	0.18	---	---	---	447
	340	6	---	F	6/74	10	0.03	---	---	---	448
	164	6	165;178	10	5/69	15	3.00	---	---	---	449
	45	6	---	10	9/67	14	0.14	---	---	---	450
	63	6	50;68;75	16	11/68	30	0.67	---	---	---	451
	59	6	---	12	11/72	26	1.44	---	---	---	452
	61	6	112;118	40	11/67	20	0.33	---	---	--	453
	68	6	---	25	10/75	16	0.24	---	---	---	454
	150	6	---	---	5/75	40	2.7	---	---	---	455
	125	6	---	40	8/72	3	.006	---	---	---	456
	97	6	---	90	8/68	20	2.00	---	---	---	457
	98	6	---	F	6/68	20	20.0	---	---	---	458
	103	6	110;125	18	4/70	35	---	---	---	---	459
	140	6	148;165	45	8/69	35	---	---	---	---	460
	62	6	---	10	10/74	12	0.60	---	---	---	461
	275	6	290;325;340	290	5/68	30	1	---	---	---	462
	105	6	108;113	50	5/76	26	0.35	---	---	---	463
	100	6	187;210	F	2/74	80	0.36	---	---	---	464
	80	6	150;150	---	10/73	15	0.09	---	---	---	465
	72	6	92;135	26	7/74	20	0.37	---	---	---	466
	70	6	70;335	110	8/72	6	0.03	---	---	---	467
	47	6	50;92;102;117	15	10/75	60	4	---	---	---	468
	50	6	501	---	---	6	0.01	---	---	---	469

TABLE 2

Well location		Owner	Driller	Date completed	Use	Altitude of land surface (feet)	Topographic setting	Aqui-/ lith
Number	Lat-Long							
Mo- 470	4059-7523	Howard Hartshorn	Leon A. Frailey	1972	H	950	V	Dclr
471	4058-7523	Henry Morier	Schantz Orchards	1969	H	890	V	Dcw/
472	4056-7523	Bernard Molnar	Anthony P. Tomsic	1972	H	750	V	Dmh/
473	4105-7514	John Rine	Charles D. Moyer	1969	H	690	V	Dclr
474	4055-7524	Delbert Kresge	Kermit K. Borger	1975	H	740	V	Dm/s
475	4055-7524	Millard Switzabel	Clair T. Miller	1968	H	750	V	Dm/s
476	4102-7509	Frank Rufo	Ralph E. Myers	1971	H	480	V	Dm/s
477	4054-7526	John McGarvey	Clair T. Miller	1967	H	695	V	Dmh/
478	4054-7526	Palmerton Hospital	Clair L. Kibler	1974	C	720	V	Dm/s
479	4022-7528	George Hawk	Andrew S. Mermon	1967	H	640	V	Dcw/
480	4050-7526	Hess	Charles D. Moyer	1967	H	---	V	Sb/r
481	4106-7516	Paradise Trout Hatchery	do.	1971	Z	915	V	Dclr
482	4058-7510	Happy Gotchel	Henry Yeska & Son, Inc.	1975	H	620	S	Dco/
483	4106-7515	H. Heydt	Hawk Drilling	1969	H	900	V	Dclr
484	4105-7518	Philip Saurman	Henry Yeska & Son, Inc.	1972	H	970	V	Dclr
485	4005-7519	Mrs. McDonnell	do.	1973	H	1220	S	Dclr
486	4058-7510	Carl Seal	Charles D. Moyer	1974	H	410	V	Dm/l
487	4103-7519	Floyd DeHaven	Leon A. Frailey	1967	H	1035	V	Qg/s
488	4102-7507	Norman Hoffman	Ralph E. Myers	1968	H	490	V	Dbf/
489	4056-7531	Joe Ravinski	Charles D. Moyer	1969	H	940	S	Dclr
490	4102-7518	Edward Geiger	Duane M. Fehr	1968	H	885	V	Dclr
491	4102-7518	Tannersville Pizzeria	Anthony P. Tomsic	1976	C	860	V	Dclr
492	4104-7519	Donald Scheffey	William Edwards	1974	H	1111	V	Dclr/
493	4057-7515	William Teel	Anthony P. Tomsic	1975	H	490	V	Dm/sl
494	4100-7517	C. and F. Builders	Henry Yeska & Son, Inc.	1974	H	785	V	Dtr/s
495	4053-7518	Rudolph Wysofsky	Richard Rumsey	1972	H	680	V	Sb/rl
496	4055-7522	P. Conrad	Leon A. Frailey	1966	H	690	V	Dm/sl
497	4054-7518	Willard Wadlick	Clair T. Miller	1968	H	690	S	Dm/sl
498	4055-7519	Chester Hauser	Leon A. Frailey	1976	H	565	V	Dm/sl
499	4057-7518	Sam Litts	Jesse L. Dogan	1976	H	620	S	Dm/sh
500	4113-7530	Audrey Scanlon	Robert Wayne Knight	1974	H	1800	S	Dcd/s
501	4108-7532	Sun Const. Co.	---	1970	H	1755	U	Dcd/s
502	4108-7534	Job 75	---	---	H	1650	U	Dcd/s
503	4105-7534	C. Poth	---	1973	H	1640	S	Dcd/s
504	4102-7532	Vincent Marconi	---	---	H	1870	H	Dcd/s
505	4105-7535	A. Blakeslee	Hawk Drilling	1967	H	1640	S	Dcd/s
506	4105-7525	Emerald Lakes	---	---	H	2000	U	Dcpg/
507	4106-7527	Ray Lise	---	---	H	1760	S	Dcpg/
508	4107-7524	Frank Dale	---	---	H	1820	U	Dcpg/
509	4100-7530	Cabrera	---	---	H	1800	S	Dcpg/
510	4114-7516	Hums	Charles D. Moyer	1973	H	1880	S	Dcpg/
511	4107-7522	Engelbart	Jesse L. Dogan	1974	H	1840	S	Dcpg/
512	4110-7523	Dean Learic	Robert Wayne Knight	1975	H	1970	---	Dcpg/
513	4051-7528	Ceaser Di-Cesa	---	1974	H	660	S	Dcw/s
514	4105-7511	---	---	---	H	1040	S	Dcw/s
515	4053-7523	Jacob Fredrick	---	---	H	970	S	Dcw/s
516	4058-7522	Orville Lloyd	Jesse L. Dogan	1974	H	1100	S	Dcw/s
517	4101-7517	Leona Kressley	Fehr's Well Drilling	1966	H	960	S	Dcw/s
518	4054-7522	Stanley Hahn	Anthony P. Tomsic	1975	H	1120	H	Dcw/s
519	4054-7523	do.	---	---	H	1100	H	Dct/s
520	4054-7522	Barry Ziegenfuss	Anthony P. Tomsic	1974	H	1145	H	Dct/s
521	4504-7508	Arthur Ley	---	---	H	1080	S	Dtr/s
522	4100-7517	Susan Langille	---	---	H	940	S	Dtr/s
523	4103-7527	Meckas	Charles D. Moyer	1970	H	1880	U	Dcpg/
								PIK
Pi- 200	4109-7458	Pocono Mtn. Lake Estates 1	Moody Drilling Co., Inc.	1973	P	1180	H	Dtr/s
201	4110-7458	Pocono Mtn. Lake Estates 6	do.	1973	P	1160	H	Dtr/s
202	4109-7457	Pocono Mtn. Lake Estates 3	do.	1973	P	680	V	Qg/--
203	4108-7458	Pocono Mtn. Lake Estates 4	do.	1973	P	700	V	Dmh/-
204	4110-7457	Pocono Mtn. Lake Estates 2A	do.	1973	P	880	V	Dtr/s
205	4108-7456	Pocono Mtn. Lake Estates 5	do.	1973	P	960	V	Dtr/s
206	4110-7456	Pocono Mtn. Lake Estates 7	do.	1973	P	1000	---	Dtr/s
207	4114-7457	Pocono Mtn. Lake Forest 2	do.	1972	P	1295	H	Dcpg/
208	4114-7457	Pocono Mtn. Lake Forest 3	do.	1972	P	1280	V	Dcpg/

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tal pth low nd face et)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
75	54	6	58;75	12	4/72	25	0.47	---	---	---	Mo- 470
90	70	6	75;85	30	6/69	30	0.86	---	---	---	471
05	50	6	150;290	30	11/72	20	20.0	---	---	---	472
45	52	6	112;128;141	38	9/69	15	0.2	---	---	---	473
20	100	6	105;110;120	15	3/75	15	---	---	---	---	474
45	132	6	142	45	7/68	35	0.70	---	---	---	475
25	84	6	148;172;220;247	---	2/71	25	0.1	---	---	---	476
35	76	6	80	9	8/67	30	1.88	---	---	---	477
35	60	6	70;85	25	4/74	35	1.40	---	---	---	478
35	74	6	74	6	4/67	20	1.11	---	---	---	479
22	103	6	110;118	45	5/67	25	25.0	---	---	---	480
30	71	6	132;257;372	50	10/71	20	0.08	---	---	---	481
0	113	6	140	55	7/75	18	0.20	---	---	---	482
5	140	6	250;280;309	70	3/69	8	0.03	---	---	---	483
5	70	6	141;210	10	11/72	8	0.04	---	---	---	484
0	127	6	141;190	57	5/73	10	0.08	---	---	---	485
0	80	6	270;342	42	2/74	8	0.61	---	---	---	486
3	---	6	---	10	9/67	60	2.00	---	---	---	487
5	31	6	114;121;133	22	4/68	30	1.36	---	---	---	488
2	72	---	100;116	40	1/69	20	0.30	---	---	---	489
0	106	6	130;155	15	7/68	8	0.06	---	---	---	490
0	125	6	175;200	4	5/76	12	0.16	---	---	---	491
0	86	6	100;140	10	6/74	100	10.0	---	---	---	492
0	50	6	100;195	30	11/75	5	0.03	---	---	---	493
0	151	6	181	18	11/74	15	---	---	---	---	494
3	68	6	73	8	8/72	30	6	---	---	---	495
5	115	6	110	0	5/66	40	1.33	---	---	---	496
0	20	---	612	95	8/68	12	0.03	---	---	---	497
7	40	6	55;80;85	15	2/76	40	1.18	---	---	---	498
0	120	6	130;160;275	60	7/76	30	0.15	---	---	---	499
5	56	6	172	25	4/74	31	0.18	---	---	---	500
3	29	6	---	20	9/70	30	0.22	---	---	---	501
0	40	6	---	18	---	17	0.22	---	---	---	502
0	43	6	194	38	7/73	25	0.28	---	---	---	503
0	21	6	---	84	---	20	0.21	---	---	---	504
2	24	6	30;115	25	10/67	15	0.15	---	---	---	505
5	41	6	---	57	---	12	0.07	---	---	---	506
5	69	---	---	48	---	12	0.35	---	---	---	507
0	41	6	---	28	---	30	1.36	---	---	---	508
8	30	6	---	8	---	20	0.32	---	---	---	509
5	24	6	87;121	28	10/73	30	0.30	---	---	---	510
8	40	6	65;98;140;188	16	---	60	0.42	---	---	---	511
0	36	6	---	25	10/75	20	2.50	---	---	---	512
0	27	6	35;120;240	25	3/74	25	0.13	---	---	---	513
3	60	---	---	60	---	9	0.01	---	---	---	514
0	76	6	---	150	---	1	0.01	---	---	---	515
2	36	6	95;105	F	9/74	20	0.25	---	---	---	516
4	54	6	95;195;221	28	8/66	6	0.03	---	---	---	517
0	21	6	320	80	8/75	4	0.02	---	---	---	518
5	42	6	---	70	---	7	0.05	---	---	---	519
5	65	6	395	120	8/74	15	0.08	---	---	---	520
1	19	6	---	25	---	10	0.07	---	---	---	521
5	41	6	---	28	---	14	0.29	---	---	---	522
3	61	6	107;147	21	7/70	20	0.29	---	---	---	523
ITY											
9	86	8	63;249;319;474;519	25	1/73	100	8.3	2	125	---	Pi- 200
9	55	8	199;230;474	128	1/73	60	1	5	160	---	201
5	120	8	120	28	1/73	110	5.95	2	---	---	202
4	61	8	264	15	10/73	35	0.7	4	210	---	203
9	133	8	172;319;459	F	11/73	350	5.14	3	175	---	204
4	80	8	76;684	2	1/73	30	1.42	4	200	---	205
3	56	8	95;124;229;458	6	1/73	60	1.39	4	215	---	206
9	42	8	30;159;174;234;279;314;356;581	70	12/72	225	8	5	250	---	207
4	50	8	95;189;436;746;804	F	---	100	.68	4	275	---	208

TABLE

Well location		Owner	Driller	Date completed	Use	Altitude of land surface (feet)	Topographic setting	Aquife litholy
Number	Lat-Long							
								WAYN
Wn- 116	4116-7522	Ravenhill Forest 3	Moody Drilling Co., Inc.	1974	P	1860	V	Dcpg/s
117	4115-7522	Ravenhill Forest 1	do.	1973	P	2010	V	Dcpg/s
118	4116-7523	Ravenhill Forest 2	do.	1973	P	2035	V	Dcpg/s
119	4116-7521	Sherwood Forest 1	do.	1973	P	1820	V	Dcpg/s
120	4116-7520	Sherwood Forest 2	do.	1973	P	1760	V	Dcpg/s
121	4116-7521	Sherwood Forest 3	do.	1973	P	1780	V	Dcpg/s
122	4116-7521	Sherwood Forest 4	do.	1973	P	1740	V	Dcpg/s
123	4116-7521	Sherwood Forest 5	do.	1973	P	1900	V	Dcpg/s
124	4118-7520	Kresswood Streams	do.	1973	P	1500	S	Dcpg/s

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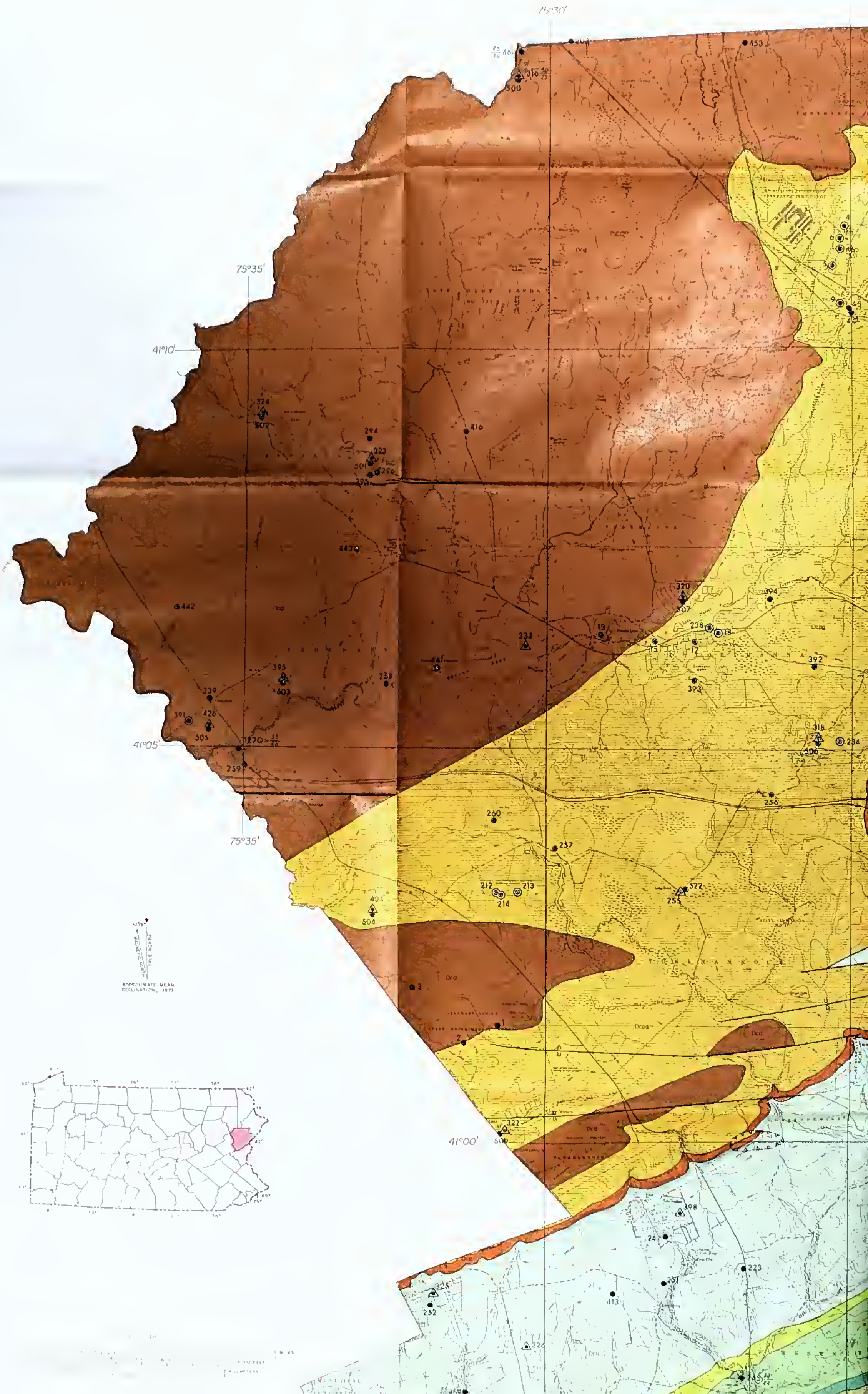
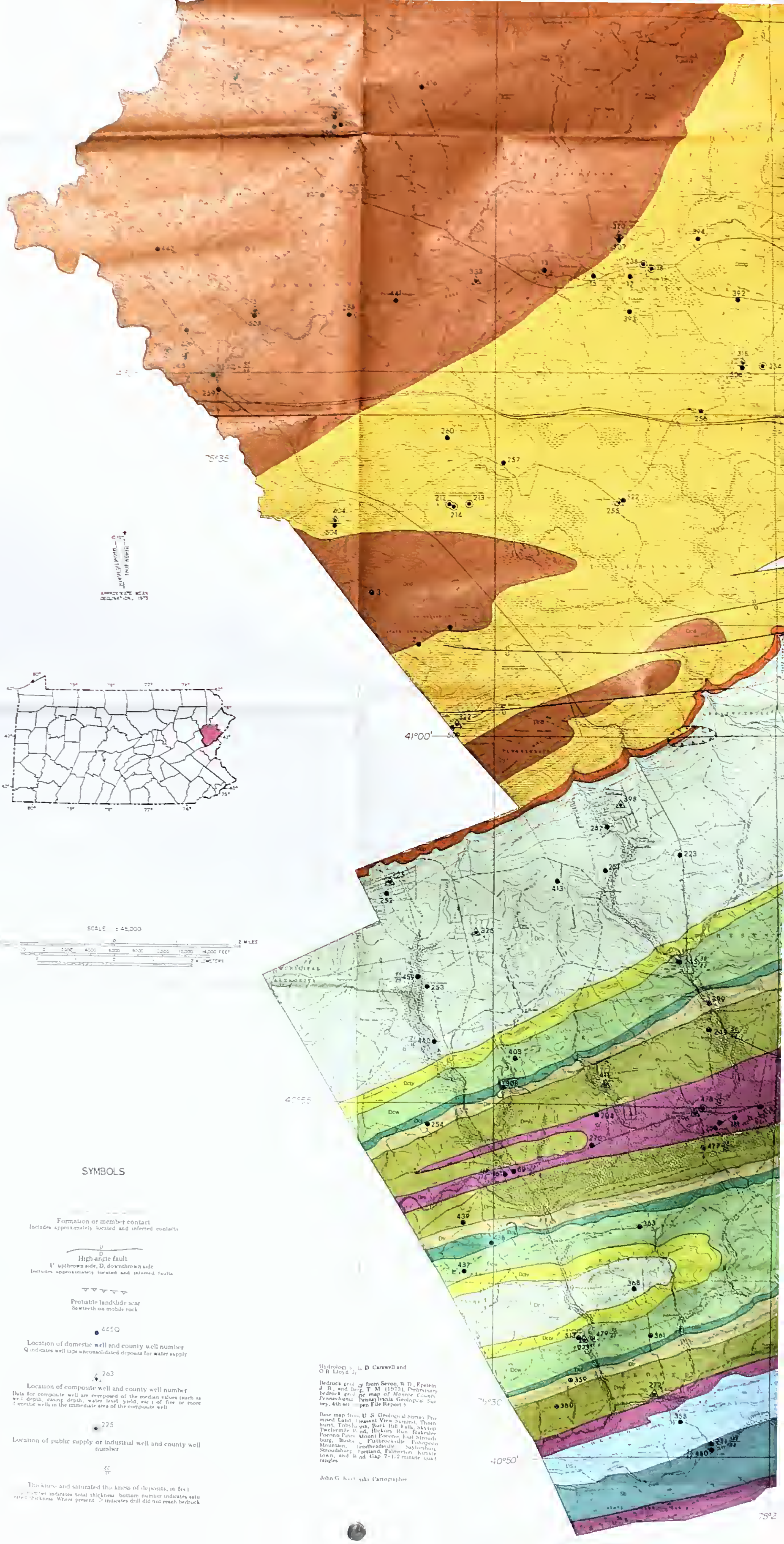
al th ow d ace t)	Casing		Depth(s) to water-bearing zone(s) (feet)	Static water level		Reported yield (gpm)	Specific capacity (gpm/ft)	Hard-ness (gpg)	Specific conduc-tance (micro-mhos at 25°C)	pH	Well number
	Depth (feet)	Diameter (inches)		Depth below land surface (feet)	Date measured (mo/yr)						
ITY											
0	55	8	65;167;303	30	7/74	140	10	---	145	---	Wn- 116
5	54	8	65;167;303	107	5/73	250	4.8	---	166	---	117
5	82	8	248	20	5/73	20	0.6	---	---	---	118
0	60	8	425	72	1/73	30	0.14	6	160	---	119
9	34	8	40;104;132	8	1/73	70	2.5	5	200	---	120
2	44	8	84;384;414;519	15	8/73	85	2.55	6	210	---	121
5	44	8	69;308	5	3/73	110	0.61	5	170	---	122
6	71	8	121;318;469	130	8/73	100	2.5	2	172	---	123
3	103	8	108;143;173;238	39	8/73	250	12.5	4	165	---	124

TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, State Geologist





SYMBOLS

Formation or member contact
Includes approximately located and inferred contacts

U
D
High-angle fault
U, upthrown side, D, downthrown side
Includes approximately located and inferred faults

Probable landslide scar
Sawteeth on mobile rock

445Q
Location of domestic well and county well number
Q indicates well taps unconsolidated deposits for water supply

263
Location of composite well and county well number
Data for composite well are composed of the median values (such as well depth, casing depth, water level, yield, etc.) of five or more domestic wells in the immediate area of the composite well

225
Location of public supply or industrial well and county well number

$\frac{65}{11}$
Thickness and saturated thickness of deposits, in feet
Top number indicates total thickness, bottom number indicates saturated thickness. Where present, > indicates drill did not reach bedrock

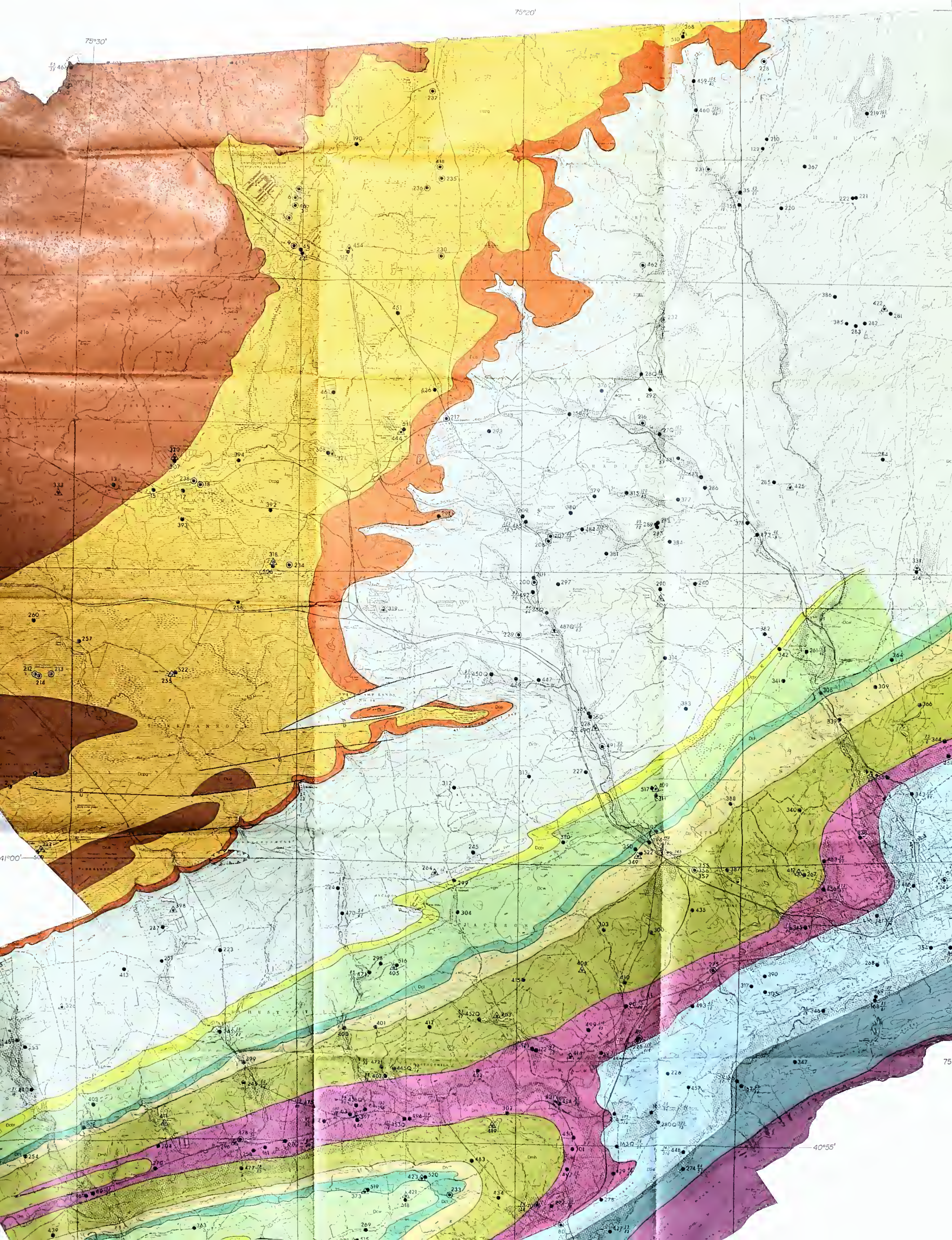
Hydrology by L. D. Carswell and O. B. Lloyd, Jr.

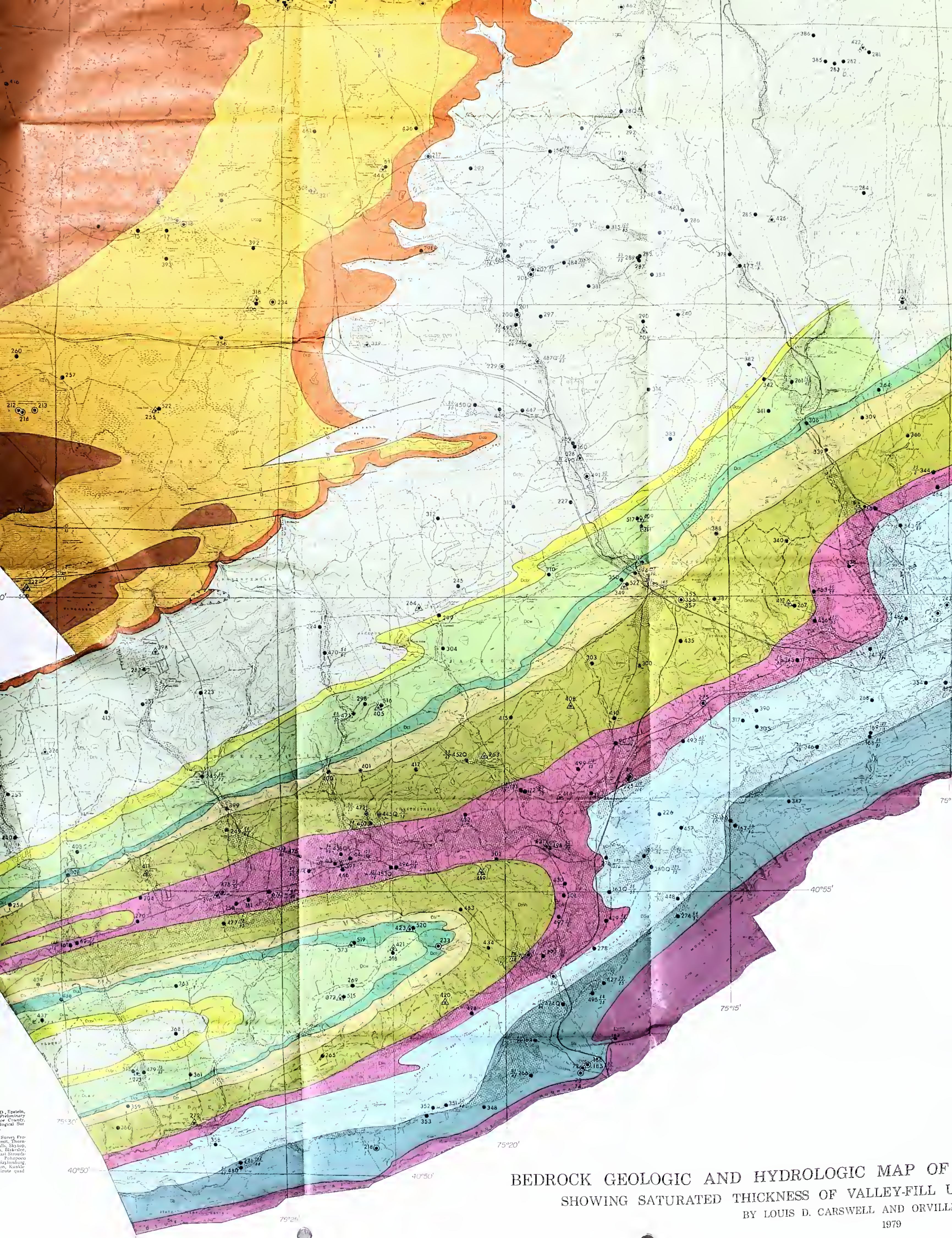
Bedrock geology from Sevon, W. D., Epstein, J. B., and Berg, T. M. (1975), *Preliminary bedrock geologic map of Monroe County, Pennsylvania*: Pennsylvania Geological Survey, 4th ser., Open File Report 6

Base map from U. S. Geological Survey Promised Land, Pleasant View Summit, Thornhurst, Tobyhanna, Buck Hill Falls, Skytop, Twelvemile Pond, Hickory Run, Blakeslee, Pocono Pines, Mount Pocono, East Stroudsburg, Bushkill, Flatbrookville, Pohopoco Mountain, Brodheadsville, Saylorsburg, Stroudsburg, Portland, Palmerton, Kunkletown, and Wind Gap 7-1/2 minute quadrangles

John G. Kuchinski, Cartographer

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES





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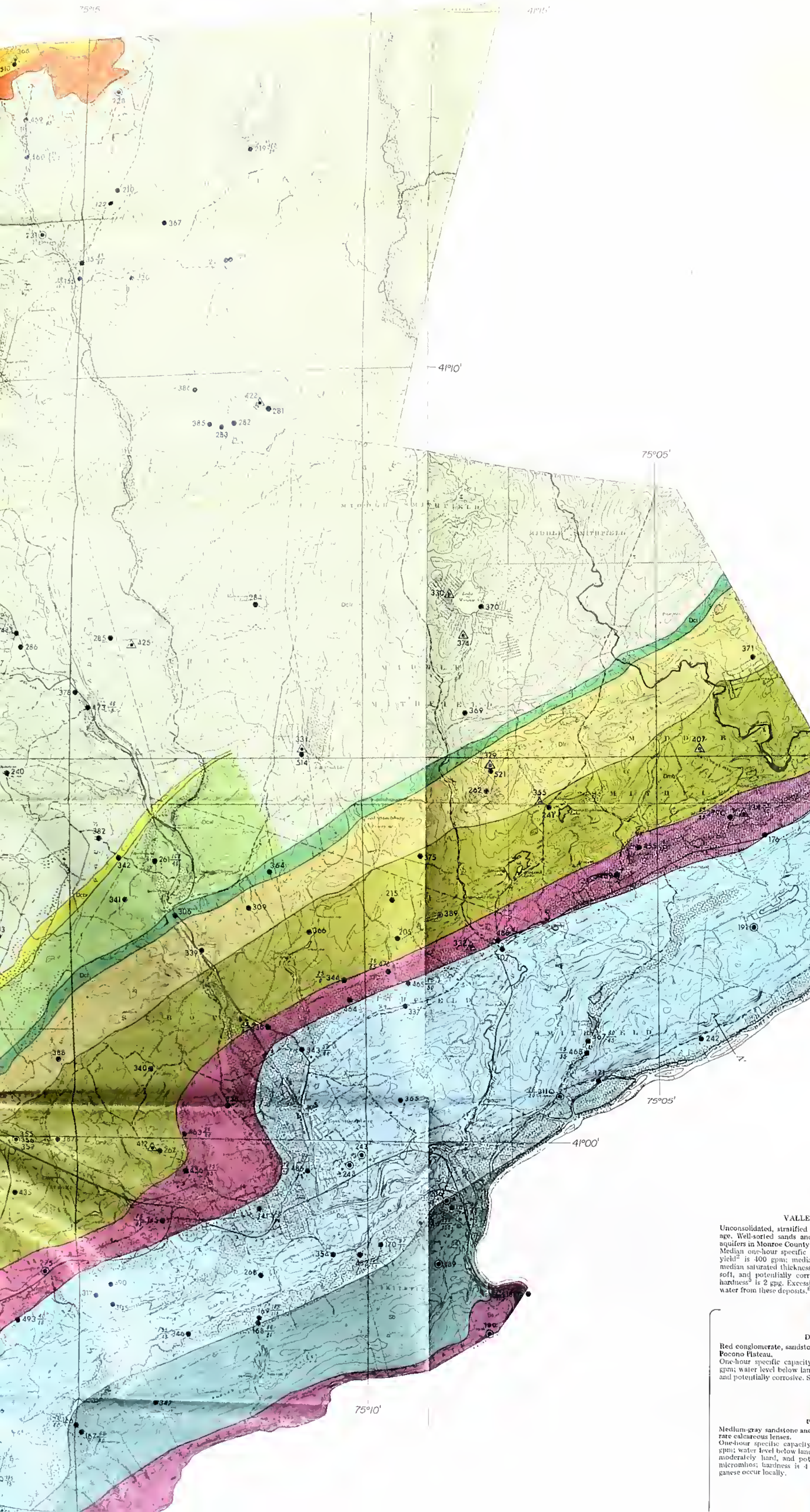
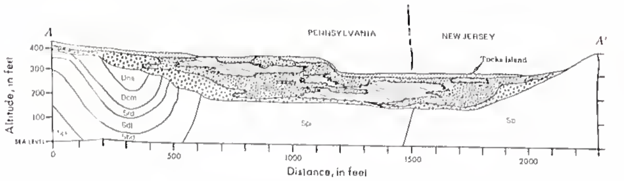
BEDROCK GEOLOGIC AND HYDROLOGIC MAP OF
SHOWING SATURATED THICKNESS OF VALLEY-FILL U

BY LOUIS D. CARSWELL AND ORVILL

1979





EXPLANATION OF SURFICIAL UNITS

ALLUVIUM
Mostly fine sands except in riverbed, where boulders occur

TILL
Heterogeneous mixture of fine to coarse material, unstratified.

GLACIOLACUSTRINE
Horizontal to slightly dipping layers of fine sand, silt, and clay
Small amount of coarse material present

FLUVIOGLACIAL
Stratified deposits of silt to cobbles.

EXPLANATION OF BEDROCK FORMATIONS

DEVONIAN

Dns - NEW SCOTLAND FORMATION
Dcm - COEYMANS FORMATION

SILURIAN

Srd - RONDOUT FORMATION
Sdl - DECKER FORMATION
Sbd - BOSSARDVILLE FORMATION
Spl - POXONO ISLAND FORMATION
Sb - BLOOMSBURG FORMATION

Note: Cross section adapted from Depman and Parrillo (1969).

EXPLANATION

VALLEY-FILL GLACIAL DEPOSITS

Unconsolidated, stratified and unstratified deposits, mainly of Quaternary age. Well-sorted sands and gravels constitute one of the most productive aquifers in Monroe County.
Median one-hour specific capacity[1] is 2.85 gpm/ft; 24-hour potential well yield[2] is 400 gpm; median water level below land surface[3] is 10 feet; median saturated thickness is 65 feet. The water is low in solutes, generally soft, and potentially corrosive. Specific conductance[4] is 117 micromhos; hardness[5] is 2 gpg. Excessive concentrations of iron and manganese occur in water from these deposits.[6]

Dcd

DUNCANNON MEMBER

Red conglomerate, sandstone, siltstone, and shale. Forms hills and ridges on Pocono Plateau.
One-hour specific capacity is 0.22 gpm/ft; 24-hour potential yield is 55 gpm; water level below land surface is 38 feet, water is low in solutes, soft, and potentially corrosive. Specific conductance is 160 micromhos.

Dcpg

POPLAR GAP MEMBER

Medium-gray sandstone and conglomerate, minor red shale and siltstone, and rare calcareous lenses.
One-hour specific capacity is 0.67 gpm/ft, 24-hour potential yield is 215 gpm; water level below land surface is 26 feet; water is low in solutes, soft to moderately hard, and potentially corrosive. Specific conductance is 154 micromhos; hardness is 4 gpg; excessive concentrations of iron and manganese occur locally.

Dcp

Dtr

TRIMMERS ROCK FORMATION

Gray and olive-gray, massive and fissile siltstone and minor shale.
One-hour specific capacity is 0.18 gpm/ft; 24-hour potential yield is 90 gpm; water level below land surface is 33 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 168 micromhos; hardness is 3.5 gpg.

Dmh

MAHANTANGO FORMATION

Medium-dark-gray siltstone and shale.
One-hour specific capacity is 0.20 gpm/ft; 24-hour potential yield is 70 gpm; water level below land surface is 26 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 200 micromhos; hardness is 2.5 gpg.

Dm

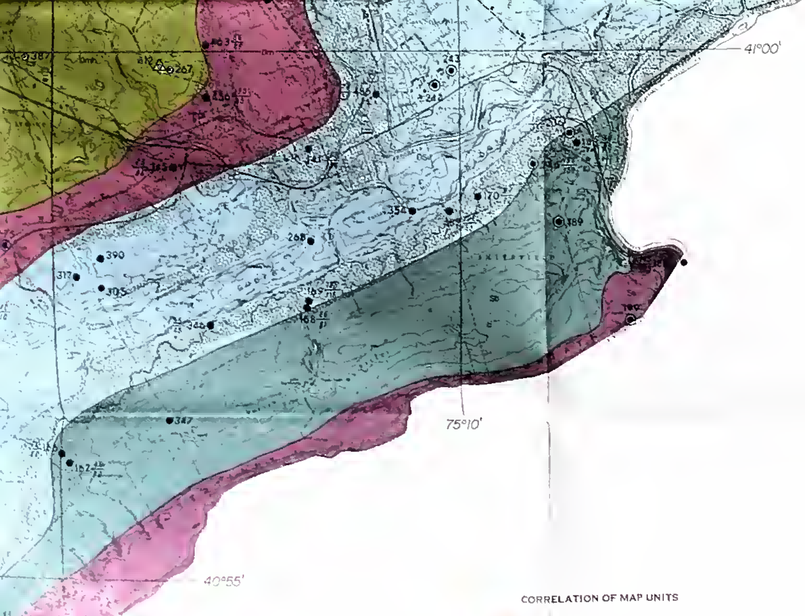
MARCELLUS FORMATION

Grayish-black, carbonaceous, fissile shale and silty shale, commonly overlain by thick, saturated, unconsolidated deposits.
One-hour specific capacity is 0.36 gpm/ft; 24-hour potential yield is 110 gpm; water level below land surface is 23 feet; water is low in solutes, soft to moderately hard, and potentially corrosive. Specific conductance is <200 micromhos; hardness is 4 gpg.

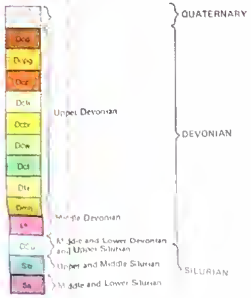
DSu

DEVONIAN AND SILURIAN ROCKS, UNDIFFERENTIATED

Structurally complex sequence of carbonate rocks, shales and siltstones, and minor calcareous sandstone and conglomerate. See Table 1 in text for a description of the individual formations in this unit.



CORRELATION OF MAP UNITS


QUATERNARY
Dcd
Dcpg
Dcp
Dclr
Dcbr
Dcw
Dct
Dtr
Dmh
Dm
DSu
Sb
Ss
Upper Devonian
DEVONIAN
Middle Devonian
Middle and Lower Devonian and Upper Silurian
Upper and Middle Silurian
SILURIAN
Middle and Lower Silurian

EXPLANATION

▨

VALLEY-FILL GLACIAL DEPOSITS

Unconsolidated, stratified and unstratified deposits, mainly of Quaternary age. Well-sorted sands and gravels constitute one of the most productive aquifers in Monroe County.

Median one-hour specific capacity[1] is 2.85 gpm ft; 24-hour potential well yield[2] is 400 gpm; median water level below land surface[3] is 10 feet, median saturated thickness is 65 feet. The water is low in solutes, generally soft, and potentially corrosive. Specific conductance[4] is 117 micromhos; hardness[5] is 2 gpg. Excessive concentrations of iron and manganese occur in water from these deposits.[6]

CATSKILL FORMATION

Dcd

DUNCANNON MEMBER

Red conglomerate, sandstone, siltstone, and shale. Forms hills and ridges on Pocono Plateau.

One-hour specific capacity is 0.22 gpm/ft; 24-hour potential yield is 55 gpm; water level below land surface is 38 feet, water is low in solutes, soft, and potentially corrosive. Specific conductance is 160 micromhos.

Dcpg

POPLAR GAP MEMBER

Medium-gray sandstone and conglomerate, minor red shale and siltstone, and rare calcareous lenses.

One-hour specific capacity is 0.67 gpm/ft; 24-hour potential yield is 215 gpm; water level below land surface is 26 feet; water is low in solutes, soft to moderately hard, and potentially corrosive. Specific conductance is 154 micromhos; hardness is 4 gpg; excessive concentrations of iron and manganese occur locally.

Dcp

PACKERTON MEMBER

Greenish-gray to gray sandstone and conglomerate and rare calcareous lenses. Cliff former at the Pocono Plateau escarpment.

Information for one well is available. One-hour specific capacity is 0.11 gpm/ft; water level below land surface is 100 feet. No water-quality data.

Dclr

LONG RUN MEMBER

Alternating gray sandstone and red siltstone and shale.

One-hour specific capacity is 0.19 gpm/ft; 24-hour potential yield is 40 gpm; water level below land surface is 46 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 160 micromhos; hardness is 2 gpg.

Dcbr

BEAVERDAM RUN MEMBER

Greenish-gray sandstone and lesser amounts of siltstone and shale.

Hydrologic information is from two wells. Average one-hour specific capacity is 0.18 gpm/ft; 24-hour potential well yield, probably the same as in the Long Run Member, is 45 gpm; average water level below land surface is 31 feet. No water-quality data.

Dcw

WALCKSVILLE MEMBER

Alternating greenish-gray sandstones and red shales.

One-hour specific capacity is 0.12 gpm/ft; 24-hour potential yield is 35 gpm; water level below land surface is 50 feet, no water-quality data.

Dct

TOWAMENSING MEMBER

Medium-gray sandstone containing interbedded silty shale and siltstone. One-hour specific capacity is 0.10 gpm/ft; 24-hour potential yield is 30 gpm; water level below land surface is 60 feet; no water-quality data.

Dtr

TRIMMERS ROCK FORMATION

Gray and olive-gray, massive and fissile siltstone and minor shale.

One-hour specific capacity is 0.18 gpm/ft; 24-hour potential yield is 90 gpm; water level below land surface is 33 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 168 micromhos; hardness is 3.5 gpg

Dmh

MAHANTANGO FORMATION

Medium-dark-gray siltstone and shale.

One-hour specific capacity is 0.20 gpm/ft; 24-hour potential yield is 70 gpm; water level below land surface is 26 feet, water is low in solutes, soft, and potentially corrosive. Specific conductance is 200 micromhos; hardness is 2.5 gpg

Dm

MARCELLUS FORMATION

Grayish-black, carbonaceous, fissile shale and silty shale, commonly overlain by thick, saturated, unconsolidated deposits.

One-hour specific capacity is 0.36 gpm/ft; 24-hour potential yield is 110 gpm; water level below land surface is 23 feet; water is low in solutes, soft to moderately hard, and potentially corrosive. Specific conductance is <200 micromhos; hardness is 4 gpg.

DSu

DEVONIAN AND SILURIAN ROCKS, UNDIFFERENTIATED

Structurally complex sequence of carbonate rocks, shales and siltstones, and minor calcareous sandstone and conglomerate. See Table 1 in text for a description of the individual formations in this unit.

One-hour specific capacity is 0.26 gpm/ft; 24-hour potential yield is 160 gpm (carbonate rocks may yield much more); water level below land surface is 15 feet. Water in noncarbonates is generally low in solutes and moderately hard, specific conductance is 200 to 400 micromhos; hardness is 5 to 7 gpg. Water in the carbonates is generally high in solutes and hard to very hard; specific conductance is 400 to 750 micromhos; hardness is 8 to 19 gpg.

Sb

BLOOMSBURG FORMATION

Red, green, and gray sandstone, siltstone, and shale. Minor conglomeratic sandstone. Commonly covered with talus and colluvium from the weathering of the Shawangunk Formation.

One-hour specific capacity is 2 gpm ft; 24-hour potential yield is 265 gpm; water level below land surface is 20 feet, Water contains moderate concentrations of dissolved solids and is moderately hard; specific conductance is 220 micromhos, hardness is 5 gpg.

Ss

SHAWANGUNK FORMATION

Quartzose sandstone and conglomerate and some siltstone and shale. Forms crests of Kittatinny and Blue Mountains.

Hydrologic data from one well indicate yields are low (5 gpm or less) and water levels are deep (as much as 212 feet below land surface). Water is low in solutes, soft, and potentially corrosive. Specific conductance is 65 micromhos; hardness is 1 gpg.

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[1] Specific-capacity data are median values taken from Table 4 in text.
[2] Yield data are 25 percent values taken from Table 6
[3] Water-level data are median values taken from Table 12.
[4] Specific-conductance data are median values taken from Table 7.
[5] Hardness data are median values taken from Table 7.
[6] Water-quality data are from two wells.

C AND HYDROLOGIC MAP OF MONROE COUNTY, PENNSYLVANIA
RATED THICKNESS OF VALLEY-FILL UNCONSOLIDATED GLACIAL DEPOSITS

BY LOUIS D. CARSWELL AND ORVILLE B. LLOYD, JR.

1979